

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
17 May 2001 (17.05.2001)

PCT

(10) International Publication Number  
**WO 01/34573 A1**

(51) International Patent Classification<sup>7</sup>: **C07D 235/28**, (74) Agent: ASTRAZENECA AB; Global Intellectual Property, S-151 85 Södertälje (SE).

(21) International Application Number: **PCT/SE00/02192**

(22) International Filing Date:

8 November 2000 (08.11.2000)

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(25) Filing Language: English

(26) Publication Language: English

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(30) Priority Data:  
9904044-6 9 November 1999 (09.11.1999) SE

(71) Applicant (*for all designated States except US*): PHARMACIA AB [SE/SE]; S-112 87 Stockholm (SE).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): ABEDI, Joseph [GH/US]; 17A Arlington Street, Cambridge, MA 02140 (US). CARCANAGUE, Daniel [US/US]; AstraZeneca R & D Boston, 35 Gatehouse Drive, Waltham, MA 02451 (US). KÜHLER, Thomas [SE/SE]; AstraZeneca R & D Mölndal, S-431 83 Mölndal (SE). SHUE, Youe-Kong [US/US]; 7869 Via Teca, Carlsbad, CA 92009 (US). WUONOLA, Mark [US/US]; AstraZeneca R & D Boston, 35 Gatehouse Drive, Waltham, MA 02451 (US).

Published:

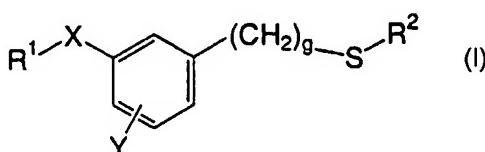
- With international search report.
- Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.



WO 01/34573 A1

(54) Title: COMPOUNDS



(57) Abstract: The invention relates to compounds of formula (I) which have anti-*Helicobacter pylori* activity.

## COMPOUNDS

The present invention relates to compounds which have anti-*Helicobacter pylori* activity, i.e., compounds which can be administered to a mammalian patient therapeutically to treat *Helicobacter pylori* infection in the patient. The invention also relates to pharmaceutical formulations, use of a compound of the invention in the manufacture of a medicament, and processes for preparing the compounds.

### Background to the Invention

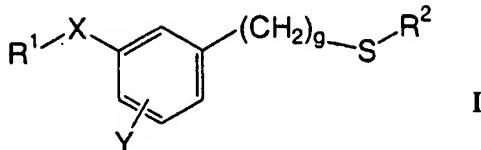
*Helicobacter pylori* is a gram negative bacterium which infects the human gastric mucosa. Infection with the bacterium causes inflammation of the gastric mucosa. Peptic ulceration of the duodenum or stomach can develop as well as adenocarcinomas or lymphomas of the stomach wall. Omeprazole (5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridinyl)methyl]sulfinyl]-1*H*-benzimidazole) is active against *Helicobacter pylori* (see Vogt, K and Hahn, H (1998), "Bactericidal Activity of Lansoprazole and Omeprazole against Helicobacter pylori in vitro", Drug Res. 48(1), No. 6, 694-697), and is labile towards rearrangement in acidic media. Omeprazole is a sulfoxide. This sulfoxide is labile towards rearrangement in acidic media and the rearrangement gives an intermediate, which is a potent proton pump inhibitor. Thus, the parent compound does not persist in the acidic environment of the stomach. Compounds related to omeprazole, where the sulphur atom is unoxidized are also active against *Helicobacter pylori*. However, these related compounds can undergo metabolic oxidation *in vivo* to give the corresponding sulfoxide, analogous to omeprazole, and have a propensity towards rearrangement in acidic media *in vivo* [J. Med. Chem. 1988, 41, 1777-1788]. Analogues which are potent against *Helicobacter pylori*, but not acid labile and thus stable in acidic media are desirable. Such analogues could be administered to a mammalian patient therapeutically to treat *Helicobacter pylori* infection.

In addition, it would be preferable for such analogues to be selective for *Helicobacter pylori*, since this is desirable to avoid the disruption of the normal gastrointestinal flora, and to reduce the incidence of bacterial resistance development.

### Summary of the Invention

Accordingly, the present invention provides compounds of formula I or pharmaceutically acceptable salts or solvates thereof which are active against *Helicobacter pylori*, but lack the pyridine nitrogen of omeprazole and its analogues which is necessary for

rearrangement in acidic media. Thus, the compounds of the invention are more stable in acid media. Formula I is as follows:



wherein:

- 5        X is S; SO<sub>2</sub>; NH; N(C<sub>1-6</sub>alkyl); O or CH<sub>2</sub>;
- Y is C<sub>1-6</sub>alkyl; O(C<sub>3-8</sub>cycloalkyl); O(C<sub>1-6</sub>alkyl); Hal; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal, OCHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal , wherein Hal represents halogen; NRR', wherein R and R' independently represent H or C<sub>1-8</sub>alkyl, or NRR' represents an optionally substituted C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; H; COOR'' or COR'', R'' representing H or C<sub>1-6</sub>alkyl; or CH<sub>2</sub>OH;
- 10      R<sup>1</sup> -(CH<sub>2</sub>)<sub>a</sub>-R<sup>3</sup>; -((CH<sub>2</sub>)<sub>b</sub>O)<sub>c</sub>-R<sup>3</sup>; -(CH<sub>2</sub>)<sub>d</sub>-R<sup>3</sup>; -(CH<sub>2</sub>)<sub>e</sub>C(=O)R<sup>3</sup>; -(CH<sub>2</sub>)<sub>f</sub>C(=O)R<sup>3</sup>; -((CH<sub>2</sub>)<sub>e</sub>O)<sub>c'</sub>-(CH<sub>2</sub>)<sub>f'</sub>-R<sup>3</sup>; R<sup>3</sup> or R<sup>3</sup>.
- R<sup>2</sup> is an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S;
- 15      R<sup>3</sup> is H; C<sub>1-6</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S;
- 20      R<sup>3</sup>' is -Z-M wherein Z represents O, S or NH and M represents H, an optionally substituted mono- or bi- cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, or an optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or -Z-M represents -C(=O)NR<sup>6</sup>R<sup>7</sup>, -NR<sup>6</sup>R<sup>7</sup>, -OC(=O)NR<sup>8</sup>R<sup>9</sup>, -NC(=O)NR<sup>8</sup>R<sup>9</sup> or -NC(=O)R<sup>8</sup>;
- 25      For R<sup>4</sup> and R<sup>5</sup>, either:
  - (i)     R<sup>4</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl, wherein Z<sup>2</sup> represents O or a bond, and the aryl is C<sub>6-10</sub>, optionally substituted and optionally fused to a C<sub>5-10</sub> heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted C<sub>6-10</sub>aryl; an

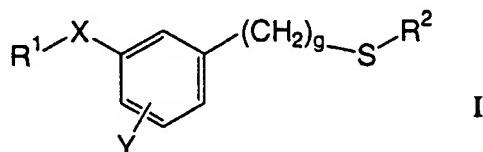
- optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2 or 3 heteroatoms independently selected from O, N and S; ( $C_{1-8}$ alkyl)-R, wherein R represents an optionally substituted mono- or bi-cyclic 5 to 10 membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted -C(=O)O( $C_{1-8}$ alkyl); optionally substituted -C(=O)O-phenyl; optionally substituted -C(=O)( $C_{1-8}$ alkyl); optionally substituted -C(=O)-phenyl; or -NC(=O)R<sup>6</sup> and 5 R<sup>5</sup> is H;  $C_{1-8}$ alkyl; optionally substituted  $C_{3-8}$ cycloalkyl optionally fused to a benzo ring; ( $C_{1-8}$ alkyl)aryl wherein the aryl is  $C_{6-10}$  and optionally substituted; optionally substituted  $C_{6-10}$ aryl; or an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring 10 structure containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or (ii) the structure -NR<sup>4</sup>R<sup>5</sup> represents a  $C_{3-8}$ heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S and optionally fused to a  $C_{6-10}$  ring structure, -NR<sup>4</sup>R<sup>5</sup> being optionally substituted;
- For R<sup>6</sup> and R<sup>7</sup>, either:
- 15 (i) R<sup>6</sup> is H;  $C_{1-12}$ alkyl; optionally substituted  $C_{3-8}$ cycloalkyl optionally fused to a benzo ring; optionally substituted ( $C_{1-8}$ alkyl)aryl wherein the aryl is  $C_{6-10}$ ; optionally substituted ( $C_{1-8}$ alkyl)R, where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S or R represents a mono-, bi- or tri-cyclic  $C_{3-13}$ cycloalkyl; optionally substituted  $C_{6-10}$ aryl; an 20 optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; or -C(=O)O-Ar, wherein Ar represents optionally substituted  $C_{6-10}$ aryl; and R<sup>7</sup> is H; or (ii) the structure -NR<sup>6</sup>R<sup>7</sup> represents a  $C_{3-8}$ heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S, -NR<sup>6</sup>R<sup>7</sup> being optionally 25 substituted;
- a represents an integer 1, 2, 3, 4 or 5;
- each b independently represents an integer 1, 2, 3, 4 or 5;
- c represents an integer 1, 2, 3, 4 or 5;
- c' represents an integer 1, 2, 3, 4 or 5;
- d represents an integer 1, 2, 3, 4 or 5;
- each e independently represents an integer 1, 2, 3, 4 or 5;
- f represents an integer 1, 2, 3, 4 or 5; and

g represents zero or an integer 1, 2, 3, 4 or 5.

The invention also relates to pharmaceutical formulations, use of a compound of the invention in the manufacture of a medicament, processes for preparing the compounds and intermediates for use in such processes.

## 5 Detailed Description of the Invention

The present invention provides a compound of formula I or a pharmaceutically acceptable salt or solvate thereof



wherein:

- 10 X represents S; SO<sub>2</sub>; NH; O or CH<sub>2</sub>. Alternatively, X represents N(C<sub>1-6</sub>alkyl), more preferably N-methyl or N(C<sub>2-4</sub>alkyl).  
Y represents C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, and most preferably methyl); O(C<sub>3-8</sub>cycloalkyl), preferably O-cyclopropyl, or O-cyclobutyl or O-cyclopentyl; O(C<sub>1-6</sub>alkyl), preferably Omethyl or O(C<sub>2-4</sub>alkyl); Hal, preferably Cl or F; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal,
- 15 OCHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal, wherein Hal represents halogen (preferably F); NRR', wherein R and R' independently represent H or C<sub>1-8</sub>alkyl (preferably methyl or C<sub>2-6</sub>alkyl or C<sub>2-4</sub>alkyl), or NRR' represents an optionally substituted C<sub>3-8</sub>, preferably C<sub>3-6</sub>, heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; H; COOR'' or COR'', R'' representing H or C<sub>1-6</sub>alkyl (preferably methyl, ethyl); or CH<sub>2</sub>OH.
- 20 For optional substitution of the heterocyclic ring represented by NRR', at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl); phenyl; OCF<sub>3</sub>; OCHF<sub>2</sub>; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-ethyl or -O(C<sub>3-6</sub>alkyl); -C(=O)O(C<sub>1-8</sub>alkyl), preferably -C(=O)O-methyl, -C(=O)O-ethyl, -C(=O)O-tert-butyl or -C(=O)O(C<sub>3-6</sub>alkyl); -C(=O)O-phenyl; -O-phenyl;
- 25 -C(=O)(C<sub>1-8</sub>alkyl), preferably -C(=O)-methyl, -C(=O)-ethyl or -C(=O)(C<sub>3-6</sub>alkyl); -C(=O)OH; -S(C<sub>1-8</sub>alkyl), preferably -S-methyl, -S-ethyl or -S(C<sub>3-6</sub>alkyl); OH; halogen (e.g., F, Cl or Br); NRR' where R and R' are independently H or C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl, most preferably R=R'=methyl); and nitro.

R<sup>1</sup> represents -(CH<sub>2</sub>)<sub>a</sub>-R<sup>3</sup>; -((CH<sub>2</sub>)<sub>b</sub>O)<sub>c</sub>-R<sup>3</sup>; -(CH<sub>2</sub>)<sub>d</sub>-R<sup>3'</sup>; -((CH<sub>2</sub>)<sub>e</sub>-O)<sub>f</sub>-(CH<sub>2</sub>)<sub>f</sub>-R<sup>3'</sup>

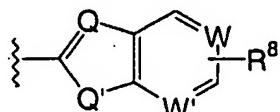
- 30 (preferably where e=2 and f=2); R<sup>3</sup> or R<sup>3'</sup>. Preferably, R<sup>1</sup> represents -(CH<sub>2</sub>)<sub>a</sub>-CH<sub>3</sub> or

- 5 -

$-\left(\left(\text{CH}_2\right)_b\text{O}\right)_c\text{CH}_3$ . More preferably,  $\text{R}^1$  is selected from  $-iso\text{-Bu}$ ;  $-(\text{CH}_2\text{CH}_2\text{O})_3\text{CH}_3$ ;  $-(\text{CH}_2\text{CH}_2)\text{-4-morpholinyl}$ ;  $-(\text{CH}_2\text{CH}_2\text{O})_5\text{CH}_3$ ;  $-(\text{CH}_2\text{CH}_2)\text{-1-(2-methyl-5-nitro-imidazolyl)}$ ;  $-(\text{CH}_2\text{CH}_2)\text{-1-(1,2,4-triazolyl)}$ ; and  $-(\text{CH}_2\text{CH}_2)\text{-OC(=O)NH-Ph}$ .

- $\text{R}^2$  represents an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S. Preferred examples of the heterocycle are benzimidazolyl (preferably benzimidazol-2-yl), imidazolyl (preferably imidazol-2-yl), oxadiazolyl (preferably 1,3,4-oxadiazol-2-yl), pyrimidinyl (preferably pyrimidin-2-yl), tetrazolyl (preferably 1,2,3,4-tetrazol-5-yl), pyridinyl (preferably pyridin-2-yl or pyridin-4-yl), thiazolyl (preferably 1,3-thiazol-2-yl), pyridineimidazolyl (preferably pyridineimidazol-2-yl), benzoxazolyl (preferably 1,3-benzoxazol-2-yl), indolyl (preferably indol-2-yl). For optional substitution of the heterocycle, at least one (e.g., one, two or three) substituents may be provided independently selected from nitro; carboxylate;  $-\text{COOH}$ ;  $=\text{O}$ ;  $-\text{S}(=\text{O})-(\text{C}_{1-8}\text{alkyl})$ , the alkyl preferably being methyl, ethyl or  $\text{C}_{3-6}\text{alkyl}$ ;  $-\text{S}(=\text{O})-(=\text{O})-(\text{C}_{1-8}\text{alkyl})$ , the alkyl preferably being methyl, ethyl or  $\text{C}_{3-6}\text{alkyl}$ ; halogen (preferably F or Cl); phenyl;  $-\text{O}(\text{C}_{1-8}\text{alkyl})$ , preferably  $-\text{O-methyl}$ ,  $-\text{O-ethyl}$  or  $-\text{O}(\text{C}_{3-6}\text{alkyl})$ ;  $-\text{S}(\text{C}_{1-8}\text{alkyl})$ , preferably  $-\text{S-methyl}$ ,  $-\text{S-ethyl}$  or  $-\text{S}(\text{C}_{3-6}\text{alkyl})$ ; OH;  $\text{OCH}_2\text{F}$ ,  $\text{OCH}_2\text{Cl}$ ,  $\text{OCF}_3$ ;  $\text{CHF}_2$ ,  $\text{CH}_2\text{F}$ ,  $\text{CF}_3$ ;  $-\text{C}(=\text{O})\text{NRR}'$ , wherein R and R' are independently selected from H and  $\text{C}_{1-8}\text{alkyl}$  (preferably methyl, ethyl, propyl, isopropyl, or  $\text{C}_{2-6}\text{alkyl}$ ), or the structure NRR' represents an optionally substituted  $\text{C}_{3-8}$ heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; and  $-\text{R}''\text{-NH(CO) R}'''$ , wherein R'' represents  $\text{C}_{1-6}$ alkylene (preferably  $\text{C}_1$  or  $\text{C}_2$ ) and R''' represents  $\text{C}_{1-6}$ alkyl (preferably  $\text{C}_1$  or  $\text{C}_2$ ).

In one preferred embodiment,  $\text{R}^2$  represents



25

wherein:

Q is CH or N;

Q' is NH, O or S;

W is CH or N;

30

W' is CH or N; and

- $R^8$  represents  $C_{1-6}$ alkyl (preferably  $C_{2-4}$ alkyl, and most preferably methyl);  $O(C_{3-8}$ cycloalkyl), preferably  $O$ -cyclopropyl, or  $O$ -cyclobutyl or  $O$ -cyclopentyl;  $O(C_{1-6}$ alkyl), preferably Omethyl or  $O(C_{2-4}$ alkyl); Hal, preferably Cl or F;  $CHal_3$ ,  $CHHal_2$ ,  $CH_2Hal$ ,  $OCHal_3$ ,  $OCHHal_2$  or  $OCH_2Hal$ , wherein Hal represents halogen (preferably F);  $NRR'$ ,
- 5 wherein R and R' independently represent H or  $C_{1-8}$ alkyl (preferably methyl or  $C_{2-6}$ alkyl or  $C_{2-4}$ alkyl), or  $NRR'$  represents an optionally substituted  $C_{3-8}$ , preferably  $C_{3-6}$ , heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; H;  $COOR^9$  or  $COR^9$ ,  $R^9$  representing H or  $C_{1-6}$ alkyl (preferably methyl, ethyl); or  $CH_2OH$ . For optional substitution of the heterocyclic ring represented by  $NRR'$ , at least one (e.g., one,
- 10 two or three) substituents may be provided independently selected from  $C_{1-6}$ alkyl (preferably  $C_{2-4}$ alkyl, more preferably methyl); phenyl;  $OCF_3$ ;  $OCHF_2$ ;  $-O(C_{1-8}$ alkyl), preferably  $-O$ -methyl,  $-O$ -ethyl or  $-O(C_{3-6}$ alkyl);  $-C(=O)O(C_{1-8}$ alkyl), preferably  $-C(=O)O$ -methyl,  $-C(=O)O$ -ethyl,  $-C(=O)O$ -*tert*-butyl or  $-C(=O)O(C_{3-6}$ alkyl);  $-C(=O)O$ -phenyl;  $-O$ -phenyl;  $-C(=O)$  ( $C_{1-8}$ alkyl), preferably  $-C(=O)$ -methyl,  $-C(=O)$ -ethyl or  $-C(=O)(C_{3-6}$ alkyl);
- 15  $-C(=O)OH$ ;  $-S(C_{1-8}$ alkyl), preferably  $-S$ -methyl,  $-S$ -ethyl or  $-S(C_{3-6}$ alkyl); OH; halogen (e.g., F, Cl or Br),  $NRR'$  where R and R' are independently H or  $C_{1-6}$ alkyl (preferably  $C_{2-4}$ alkyl, more preferably methyl, most preferably  $R=R'=methyl$ ); and nitro.

- $R^3$  represents H;  $C_{1-6}$ alkyl; optionally substituted  $C_{3-8}$ , preferably  $C_{3-6}$ , cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S;
- 20 optionally substituted  $C_{5-10}$ aromatic ring structure (e.g., phenyl) optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S. Preferably, the cycloalkyl contains heteroatoms and is selected from morpholinyl (4-morpholinyl), piperazinyl (preferably 1-piperazinyl),
- 25 tetrazolyl (preferably 1,2,3,4-tetrazol-2-yl), imidazolyl (e.g., 1-imidazolyl) and triazolyl (e.g., 1-(1,2,4-triazolyl)). Preferred examples of the  $C_{1-6}$ alkyl are preferably  $C_{2-4}$ alkyl, methyl and butyl (e.g., isobutyl). preferred examples of the heterocyclic ring structure are imidazopyridazine (more preferably 6-imidazo[1,2-*b*]pyridazine) and imidazolyl (more preferably 1-imidazolyl). For optional substitution of the cycloalkyl, aryl or heterocyclic ring,
- 30 at least one (e.g., one, two or three) substituents may be provided independently selected from  $C_{1-6}$ alkyl (preferably  $C_{2-4}$ alkyl, more preferably methyl) and nitro.

R<sup>3'</sup> represents -Z-M wherein Z represents O, S or NH and M represents H, an optionally substituted mono- or bi- cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, or an optionally substituted C<sub>5-10</sub>aromatic ring structure (e.g., phenyl) optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or -Z-M -C(=O)NR<sup>6</sup>R<sup>7</sup>, -NR<sup>6</sup>R<sup>7</sup>, -OC(=O)NR<sup>8</sup>R<sup>9</sup>, -NC(=O)NR<sup>8</sup>R<sup>9</sup> or -NC(=O)R<sup>8</sup>;

5 Preferably, the heterocyclic ring structure is selected from imidazopyridazine (more preferably 6-imidazo[1,2-*b*]pyridazine) and imidazolyl (more preferably 1-imidazolyl). For optional substitution of the aromatic or heterocyclic ring structure, at least one (e.g., one, two or three)

10 substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl) and nitro.

Most preferably, R<sup>3'</sup> is selected from -4-morpholinyl; -1-(2-methyl-5-nitro-imidazolyl); -1-(1,2,4-triazolyl); and -OC(=O)NH-Ph.

For R<sup>4</sup> and R<sup>5</sup>, either:

- 15 (i) R<sup>4</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl, wherein Z<sup>2</sup> represents O or a bond, and the aryl is C<sub>6-10</sub>, optionally substituted and optionally fused to a C<sub>5-10</sub> heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2 or 3
- 20 heteroatoms independently selected from O, N and S; (C<sub>1-8</sub>alkyl)-R, wherein R represents an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted -C(=O)O(C<sub>1-8</sub>alkyl); optionally substituted -C(=O)O-phenyl; optionally substituted -C(=O)(C<sub>1-8</sub>alkyl); optionally substituted -C(=O)-phenyl; or -NHC(=O)R<sup>6</sup>; and
- 25 R<sup>5</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub> and optionally substituted; optionally substituted C<sub>6-10</sub>aryl; or an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or
- (ii) the structure -NR<sup>4</sup>R<sup>5</sup> represents a C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3
- 30 further heteroatoms independently selected from O, N and S and optionally fused to a C<sub>6-10</sub>ring structure, -NR<sup>4</sup>R<sup>5</sup> being optionally substituted.

- For R<sup>4</sup> in option (i), preferably the C<sub>1-8</sub>alkyl or the C<sub>1-8</sub>alkyl in Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl or the C<sub>1-8</sub>alkyl in (C<sub>1-8</sub>alkyl)-R or the C<sub>1-8</sub>alkyl in -C(=O)O(C<sub>1-8</sub>alkyl) or the C<sub>1-8</sub>alkyl in -C(=O)(C<sub>1-8</sub>alkyl) is selected from C<sub>2-6</sub>alkyl, methyl, ethyl, propyl (e.g., isopropyl), butyl (e.g., isobutyl or *tert*-butyl) and pentyl. Preferably, where C<sub>6-10</sub>aryl is mentioned, the aryl is phenyl.
- 5 Preferably, Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl represents Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)benzodioxol. Preferably, for R<sup>4</sup>, where a heterocyclic ring structure is mentioned, this is selected from furyl (e.g., 2-furyl), tetrahydrofuranyl (e.g., tetrahydro-2-furanyl), thienyl (e.g., 2-thienyl), morpholinyl (e.g., 4-morpholinyl), isoxazolyl (e.g., 4-isoxazolyl or 5-isoxazolyl), dioxoimidazolidinyl (e.g., 2,5-dioxoimidazolidinyl), pyrazinyl, dioxotetrahydropurinyl (e.g., 2,6-dioxo-1,2,3,6-tetrahydro-10 purin-7-yl), benzofuranyl (e.g., 2-benzofuranyl), pyridyl (e.g., 2-pyridyl or 3-pyridyl), quinolyl (e.g., 4-quinolyl), pyrrolidinyl (e.g., 2-pyrrolidinyl), piperazinyl (e.g., 1-piperazinyl), imidazopyridazinyl (e.g., imidazo[1,2-*b*]pyridazinyl) and tetrazolyl (e.g., tetrazol-2-yl, 1,2,3,4-tetrazol-2-yl). Preferably, for Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl, the aryl is optionally fused to a heterocyclic ring structure selected from furan, tetrahydrofuran, thiophene, morpholine, isoxazole,
- 15 dioxoimidazolidine (e.g., 2,5-dioxoimidazolidine), pyrazine, dioxotetrahydropurine (e.g., 2,6-dioxo-1,2,3,6-tetrahydro-purine), benzofuran, pyridine, quinoline, pyrrolidine, piperazine, imidazopyridazine (e.g., imidazo[1,2-*b*]pyridazine) and tetrazole (e.g., 1,2,3,4-tetrazole).
- Preferably, the C<sub>3-8</sub>cycloalkyl is selected from cyclopropyl C<sub>4-6</sub>cycloalkyl and cyclopentyl. For optional substitution of the cycloalkyl, aryl, heterocycle or heterocyclic ring structure, at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl); phenyl; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-ethyl or -O(C<sub>3-6</sub>alkyl); -C(=O)O(C<sub>1-8</sub>alkyl), preferably -C(=O)O-methyl, -C(=O)O-ethyl or -C(=O)O(C<sub>3-6</sub>alkyl); -C(=O)O-phenyl; -O-phenyl; -C(=O) (C<sub>1-8</sub>alkyl), preferably -C(=O)-methyl, -C(=O)-ethyl or -C(=O)(C<sub>3-6</sub>alkyl); -S(C<sub>1-8</sub>alkyl), preferably -S-methyl, -S-ethyl or -S(C<sub>3-6</sub>alkyl); OH; halogen (e.g., F, Cl or Br), NRR' where R and R' are independently H or C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl, most preferably R=R'=methyl); and nitro.

For option (ii), the C<sub>3-8</sub>heterocyclic ring is preferably selected from piperidinyl (e.g., 1-piperidinyl), piperazinyl (e.g., 1-piperazinyl), morpholinyl (e.g., 4-morpholinyl) and tetrazolyl (e.g., 1,2,3,4-tetrazol-2-yl). Preferably, the C<sub>6-10</sub> ring structure is selected from cyclohexyl and a benzo ring. For optional substitution of -NR<sup>4</sup>R<sup>5</sup>, at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl); phenyl; OCF<sub>3</sub>; OCHF<sub>2</sub>; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-

- ethyl or  $-O(C_{3-6}\text{alkyl})$ ;  $-C(=O)O(C_{1-8}\text{alkyl})$ , preferably  $-C(=O)O\text{-methyl}$ ,  $-C(=O)O\text{-ethyl}$ ,  $-C(=O)O\text{-}tert\text{-butyl}$  or  $-C(=O)O(C_{3-6}\text{alkyl})$ ;  $-O\text{-phenyl}$ ;  $-C(=O)(C_{1-8}\text{alkyl})$ , preferably  $-C(=O)\text{-methyl}$ ,  $-C(=O)\text{-ethyl}$  or  $-C(=O)(C_{3-6}\text{alkyl})$ ;  $-C(=O)OH$ ;  $-S(C_{1-8}\text{alkyl})$ , preferably  $-S\text{-methyl}$ ,  $-S\text{-ethyl}$  or  $-S(C_{3-6}\text{alkyl})$ ; OH; halogen (e.g., F, Cl or Br), NRR' where R and R' are independently H or  $C_{1-6}\text{alkyl}$  (preferably  $C_{2-4}\text{alkyl}$ , more preferably methyl, most preferably  $R=R'=\text{methyl}$ ); and nitro.

For  $R^6$  and  $R^7$ , either:

- (i)  $R^6$  is H;  $C_{1-12}\text{alkyl}$ ; optionally substituted  $C_{3-8}\text{cycloalkyl}$  optionally fused to a benzene ring; optionally substituted ( $C_{1-8}\text{alkyl})\text{aryl}$  wherein the aryl is  $C_{6-10}$ ; optionally substituted  $(C_{1-8}\text{alkyl})R$ , where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S or R represents a mono-, bi- or tri-cyclic  $C_{3-13}\text{cycloalkyl}$ ; optionally substituted  $C_{6-10}\text{aryl}$ ; an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; or  $-C(=O)-O\text{-Ar}$ , wherein Ar represents optionally substituted  $C_{6-10}\text{aryl}$ ; and  $R^7$  is H; or
- (ii) the structure  $-NR^6R^7$  represents a  $C_{3-8}\text{heterocyclic}$  ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S and optionally fused to a  $C_{6-10}$  ring structure,  $-NR^6R^7$  being optionally substituted.

- For  $R^6$  in option (ii), preferably  $C_{1-12}\text{alkyl}$  is selected from  $C_{1-8}\text{alkyl}$ ,  $C_{2-6}\text{alkyl}$ , methyl, propyl (e.g., isopropyl), butyl (e.g., isobutyl or *tert*-butyl), pentyl and adamantyl (e.g., 1-adamantyl). For  $C_{1-8}\text{alkyl}$  in  $(C_{1-8}\text{alkyl})\text{aryl}$  or  $(C_{1-8}\text{alkyl})R$ , the alkyl is selected from  $C_{2-6}\text{alkyl}$ , methyl, propyl (e.g., isopropyl), butyl (e.g., isobutyl or *tert*-butyl) and pentyl. Preferably, where  $C_{6-10}\text{aryl}$  is mentioned, the aryl is phenyl. Preferably,  $Z^2-(C_{1-8}\text{alkyl})\text{aryl}$  represents  $Z^2-(C_{1-8}\text{alkyl})\text{benzodioxol}$ . Preferably, where a 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle is mentioned, this is selected from benzofuryl (e.g., benzofur-2-yl), furyl (e.g., 2-furyl), tetrahydrofuryl (e.g., tetrahydro-2-furanyl), thienyl (e.g., 2-thienyl), morpholinyl (e.g., 4-morpholinyl), isoxazolyl (e.g., 4-isoxazolyl or 5-isoxazolyl), dioxoimidazolidinyl (e.g., 2,5-dioxoimidazolidinyl), pyrazinyl, dioxotetrahydropurinyl (e.g., 2,6-dioxo-1,2,3,6-tetrahydro-purin-7-yl), benzofuranyl (e.g., 2-benzofuranyl), pyridyl (e.g., 2-pyridyl or 3-pyridyl), quinolyl (e.g., 4-quinolyl), pyrrolidinyl (e.g., 2-pyrrolidinyl), piperazinyl (e.g., 1-piperazinyl), imidazopyridazinyl (e.g., imidazo[1,2-*b*]pyridazinyl) and tetrazolyl (e.g., tetrazol-2-yl, 1,2,3,4-tetrazol-2-yl). Preferably, the  $C_{3-8}\text{cycloalkyl}$  is selected from cyclopropyl  $C_{4-6}\text{cycloalkyl}$  and cyclopentyl. For optional substitution of the cycloalkyl, alkylaryl, aryl or

heterocycle, at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl); phenyl; OCF<sub>3</sub>; OCHF<sub>2</sub>; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-ethyl or -O(C<sub>3-6</sub>alkyl); -C(=O)O(C<sub>1-8</sub>alkyl), preferably -C(=O)O-methyl, -C(=O)O-ethyl, -C(=O)O-*tert*-butyl or -C(=O)O(C<sub>3-6</sub>alkyl);

- 5 -C(=O)O-phenyl; -O-phenyl; -C(=O) (C<sub>1-8</sub>alkyl), preferably -C(=O)-methyl, -C(=O)-ethyl or -C(=O)(C<sub>3-6</sub>alkyl); -C(=O)OH; -S(C<sub>1-8</sub>alkyl), preferably -S-methyl, -S-ethyl or -S(C<sub>3-6</sub>alkyl); OH; halogen (e.g., F, Cl or Br), NRR' where R and R' are independently H or C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl, most preferably R=R'=methyl); and nitro.

For option (ii), the C<sub>3-8</sub>heterocyclic ring is preferably selected from piperidinyl (e.g., 1-piperidinyl), piperazinyl (e.g., 1-piperazinyl), morpholinyl (e.g., 4-morpholinyl) and tetrazolyl (e.g., 1,2,3,4-tetrazol-2-yl). Preferably, the C<sub>6-10</sub>ring structure is selected from cyclohexyl and a benzo ring. For optional substitution of -NR<sup>6</sup>R<sup>7</sup>, at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl); phenyl; OCF<sub>3</sub>; OCHF<sub>2</sub>; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-ethyl or -O(C<sub>3-6</sub>alkyl); -C(=O)O(C<sub>1-8</sub>alkyl), preferably -C(=O)O-methyl, -C(=O)O-ethyl or -C(=O)O(C<sub>3-6</sub>alkyl); -O-phenyl; -C(=O) (C<sub>1-8</sub>alkyl), preferably -C(=O)-methyl, -C(=O)-ethyl or -C(=O)(C<sub>3-6</sub>alkyl); -S(C<sub>1-8</sub>alkyl), preferably -S-methyl, -S-ethyl or -S(C<sub>3-6</sub>alkyl); OH; halogen (e.g., F, Cl or Br), NRR' where R and R' are independently H or C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl, most preferably R=R'=methyl); and nitro.

20 In formula I, a represents 1, 2, 3, 4 or 5 (preferably 1 or 2); each b independently represents 1, 2, 3, 4 or 5 (preferably 1 or 2); c represents 1, 2, 3, 4 or 5 (preferably 1 or 2); c' represents 1, 2, 3, 4 or 5 (preferably 1 or 2); d represents 1, 2, 3, 4 or 5 (preferably 1 or 2); each e independently represents 1, 2, 3, 4 or 5 (preferably 1 or 2); f represents 1, 2, 3, 4 or 5 (preferably 1 or 2); and g represents zero or represents 1, 2, 3, 4 or 5 (preferably 1 or 2).

25 In the present specification, unless otherwise indicated, an alkyl substituent may be linear or branched.

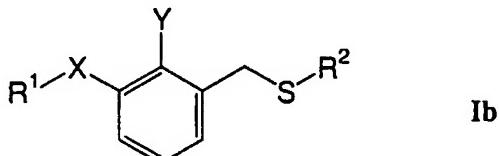
Where optional substitution of aryl is mentioned, the substituent can be selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, and most preferably methyl); O(C<sub>3-8</sub>cycloalkyl), preferably O-cyclopropyl, or O-cyclobutyl or O-cyclopentyl; O(C<sub>1-6</sub>alkyl), preferably Omethyl or O(C<sub>2-4</sub>alkyl); Hal, preferably Cl or F; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal, OCHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal, wherein Hal represents halogen (preferably F); NRR', wherein R and R' independently represent H or C<sub>1-8</sub>alkyl (preferably methyl or C<sub>2-6</sub>alkyl or C<sub>2-4</sub>alkyl), or NRR' represents an optionally substituted C<sub>3-8</sub>, preferably C<sub>3-6</sub>, heterocyclic ring optionally

containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; H; COOR'' or COR'', R'' representing H or C<sub>1-6</sub>alkyl (preferably methyl, ethyl); or CH<sub>2</sub>OH. For optional substitution of the heterocyclic ring represented by NRR', at least one (e.g., one, two or three) substituents may be provided independently selected from C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl,

- 5 more preferably methyl); phenyl; OCF<sub>3</sub>; OCHF<sub>2</sub>; -O(C<sub>1-8</sub>alkyl), preferably -O-methyl, -O-ethyl or -O(C<sub>3-6</sub>alkyl); -C(=O)O(C<sub>1-8</sub>alkyl), preferably -C(=O)O-methyl, -C(=O)O-ethyl, -C(=O)O-*tert*-butyl or -C(=O)O(C<sub>3-6</sub>alkyl); -C(=O)O-phenyl; -O-phenyl; -C(=O) (C<sub>1-8</sub>alkyl), preferably -C(=O)-methyl, -C(=O)-ethyl or -C(=O)(C<sub>3-6</sub>alkyl); -C(=O)OH; -S(C<sub>1-8</sub>alkyl), preferably -S-methyl, -S-ethyl or -S(C<sub>3-6</sub>alkyl); OH; halogen (e.g., F, Cl or Br), NRR' where R and R' are independently H or C<sub>1-6</sub>alkyl (preferably C<sub>2-4</sub>alkyl, more preferably methyl, most preferably R=R'=methyl); and nitro.
- 10

In one embodiment, a is 1, 2 or 3; b is 2; c' is 1, 2, 3, 4 or 5; d is 1, 2 or 3; e is 2; f is 1, 2 or 3; and g is 1 or 2.

Another embodiment has the general structure Ib



15

wherein:

X is S, S(=O), S(=O)<sub>2</sub> or O.

Y is C<sub>1-6</sub>alkyl, O(C<sub>1-6</sub>alkyl), Hal; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal, OCHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal.

- 20 R<sup>1</sup> is -(CH<sub>2</sub>)<sub>a</sub>-R<sup>3</sup>, -((CH<sub>2</sub>)<sub>2</sub>O)<sub>c</sub>-R<sup>3</sup>, -(CH<sub>2</sub>)<sub>d</sub>-R<sup>3</sup>', -(CH<sub>2</sub>)<sub>a</sub>C(=O)R<sup>3</sup>, -(CH<sub>2</sub>)<sub>d</sub>C(=O)R<sup>3</sup>', -((CH<sub>2</sub>)<sub>2</sub>O)<sub>c</sub>'-(CH<sub>2</sub>)<sub>f</sub>-R<sup>3</sup>.

- 25 R<sup>3</sup> is C<sub>1-6</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle.

- 30 R<sup>3</sup>' is -Z-M wherein Z represents O, S or NH and M represents H, an optionally substituted mono- or bi- cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure

containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or an optionally substituted C<sub>5-10</sub> aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or -Z-M represents

- 5 -C(=O)NR<sup>6</sup>R<sup>7</sup>, -NR<sup>6</sup>R<sup>7</sup>, -OC(=O)NR<sup>8</sup>R<sup>9</sup>, -NC(=O)NR<sup>8</sup>R<sup>9</sup> or -NC(=O)R<sup>8</sup>.

For R<sup>6</sup> and R<sup>7</sup>, either:

- (i) R<sup>6</sup> is H; C<sub>1-12</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; optionally substituted (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub>; optionally substituted (C<sub>1-8</sub>alkyl)R, where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered
- 10 heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or R represents a mono-, bi- or tri-cyclic C<sub>3-13</sub>cycloalkyl; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected
- 15 from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or -C(=O)-O-Ar, wherein Ar represents optionally substituted C<sub>6-10</sub>aryl; and

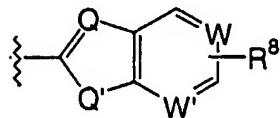
R<sup>7</sup> is H; or

- (ii) the structure -NR<sup>6</sup>R<sup>7</sup> represents a C<sub>3-8</sub> heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; -NR<sup>6</sup>R<sup>7</sup> being optionally substituted.

In one variation of the above embodiments, X is S or O; R<sup>1</sup> is -(CH<sub>2</sub>)<sub>2</sub>R<sup>3</sup>, -(CH<sub>2</sub>)<sub>2</sub>R<sup>3</sup>', -CH<sub>2</sub>C(=O)R<sup>3</sup> or -CH<sub>2</sub>C(=O)R<sup>3</sup>'; and R<sup>3</sup> is optionally substituted C<sub>3-8</sub>cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S.

- 30 In another variation of the above embodiments, R<sup>1</sup> is selected from -iso-Bu, -(CH<sub>2</sub>CH<sub>2</sub>O)<sub>3</sub>CH<sub>3</sub>, -(CH<sub>2</sub>CH<sub>2</sub>)-4-morpholinyl, -(CH<sub>2</sub>CH<sub>2</sub>O)<sub>5</sub>CH<sub>3</sub>, -(CH<sub>2</sub>CH<sub>2</sub>)-1-(2-methyl-5-nitro-imidazolyl), -(CH<sub>2</sub>CH<sub>2</sub>)-1-(1,2,4-triazolyl), and -(CH<sub>2</sub>CH<sub>2</sub>)-OC(=O)NH-Ph.

In still another variation of the above embodiments, R<sup>2</sup> represents



wherein:

Q is CH or N;

5 Q' is NH, O or S;

W is CH or N;

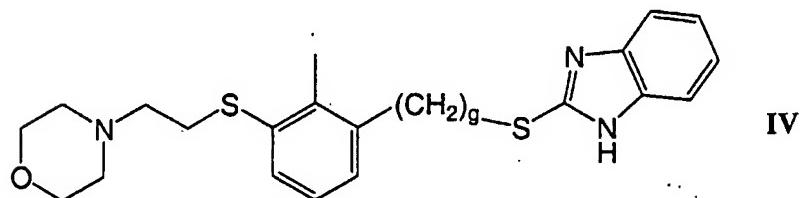
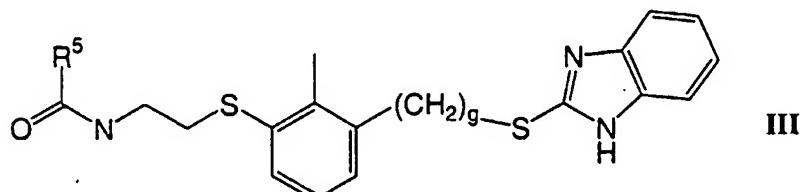
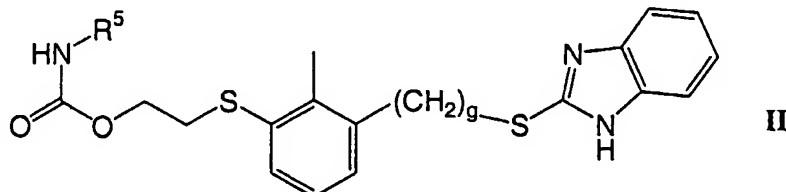
W' is CH or N; and

R<sup>8</sup> is C<sub>1-6</sub>alkyl; O(C<sub>3-8</sub>cycloalkyl); O(C<sub>1-6</sub>alkyl); Hal; CHHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal,

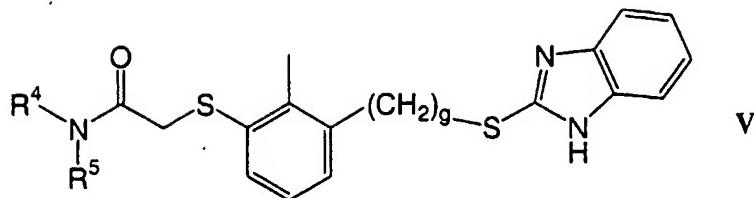
OCHHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal, wherein Hal represents halogen; NRR', wherein R and R'

10 independently represent H or C<sub>1-8</sub>alkyl, or NRR' represents an optionally substituted C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S; H; COOR<sup>9</sup> or COR<sup>9</sup>, R<sup>9</sup> representing H or C<sub>1-6</sub>alkyl; or CH<sub>2</sub>OH.

15 Preferred compounds are selected from compounds II, III, IV and V

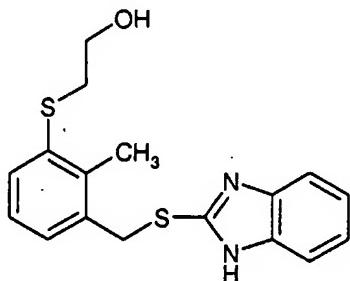


- 14 -



Specific examples of compounds according to the invention are given below. Mass spectral molecular ion data are reported in units of m/z (mass/charge) in Daltons.

**Compound 1**

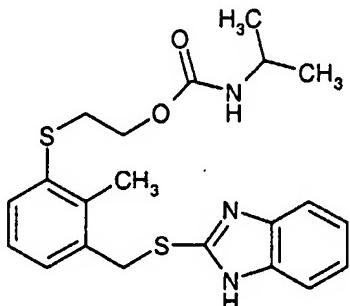


5

Mass spec' molecular ion: M+H= 331

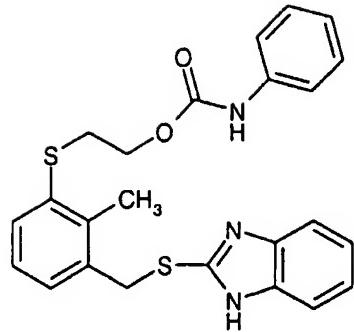
2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)-1-ethanol

**Compound 2**



10 Mass spec' molecular ion: M+H=417

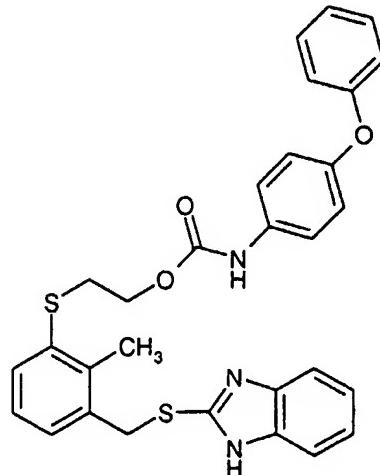
2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl isopropylcarbamate

**Compound 3**

Mass spec' molecular ion: M+H= 450

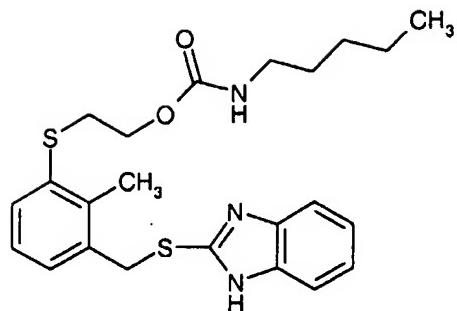
2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl

5 phenylcarbamate

**Compound 4****NMR:**

<sup>1</sup>H NMR (dmso-d6) ppm 2.42 (s, 3H), 3.26 (t, J=6.7 Hz, 2H), 4.22 (t, J=6.7 Hz, 2H), 4.62 (s, 2H), 6.95-7.68 (m, 16H), 9.57 (s, 1H, NH), 12.61 (s, 1H, NH).

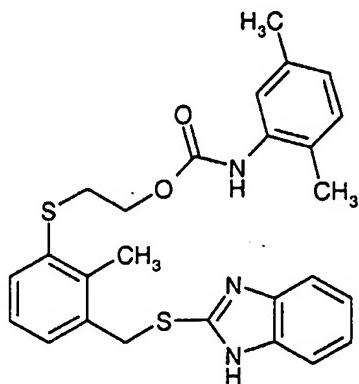
10 2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl 4-phenoxyphenylcarbamate

**Compound 5**

Mass spec' molecular ion: M+H= 445

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl

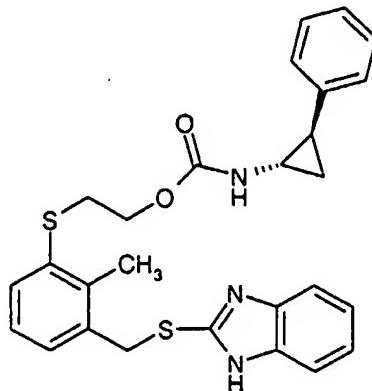
5 pentylicarbamate

**Compound 6**

Mass spec' molecular ion: M+H= 479

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2,5-

10 dimethylphenylcarbamate

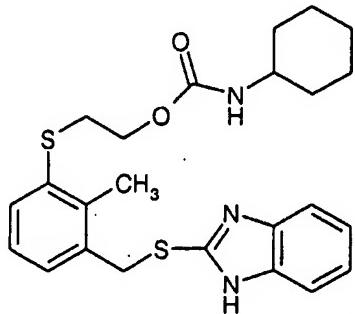
**Compound 7**

Mass spec' molecular ion: M+H= 490

- 17 -

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl (1*S*,2*R*)-2-phenylcyclopropylcarbamate

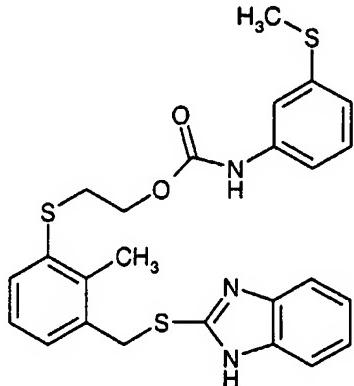
**Compound 8**



5 Mass spec' molecular ion: M+H= 456

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl cyclohexylcarbamate

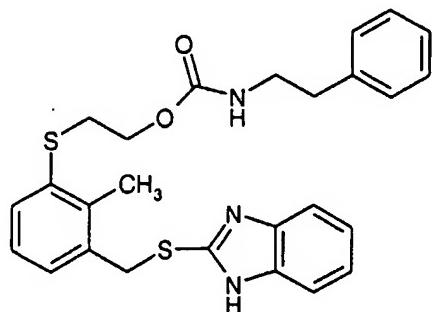
**Compound 9**



10 Mass spec' molecular ion: M+H= 496

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl 3-(methylsulfanyl)phenylcarbamate

**Compound 10**

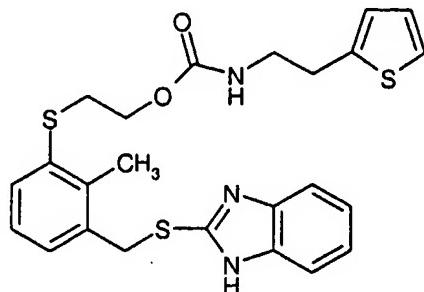


- 18 -

Mass spec' molecular ion: M+H= 478

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenethylcarbamate

**Compound 11**

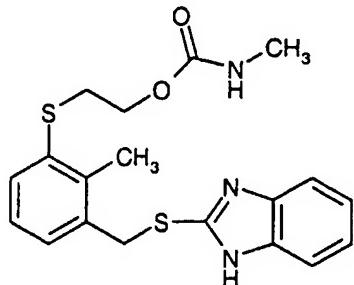


5

Mass spec' molecular ion: M+H= 484

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2-(2-thienyl)ethylcarbamate

**Compound 12**

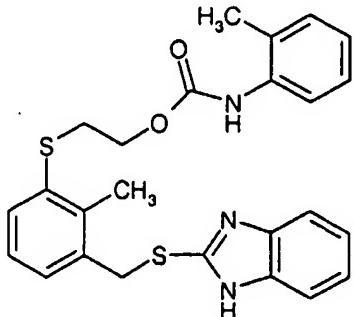


10

Mass spec' molecular ion: M+H= 388

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl methylcarbamate

**Compound 13**



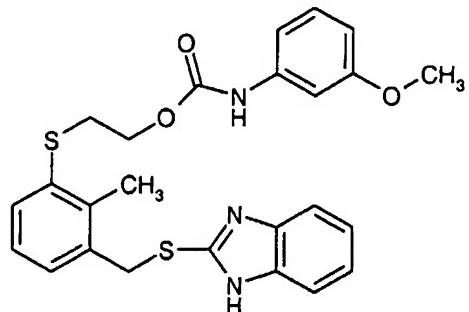
15

Mass spec' molecular ion: M+H= 464

- 19 -

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2-methylphenylcarbamate

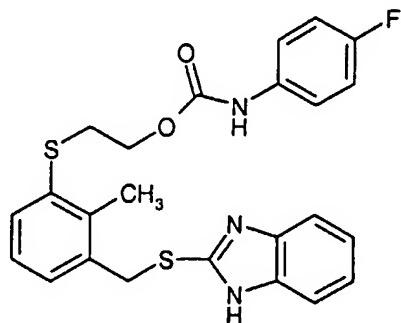
**Compound 14**



5 Mass spec' molecular ion: M+H= 480

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-methoxyphenylcarbamate

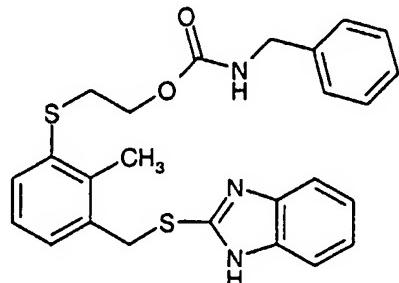
**Compound 15**



10 Mass spec' molecular ion: M+H= 468

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-fluorophenylcarbamate

**Compound 16**

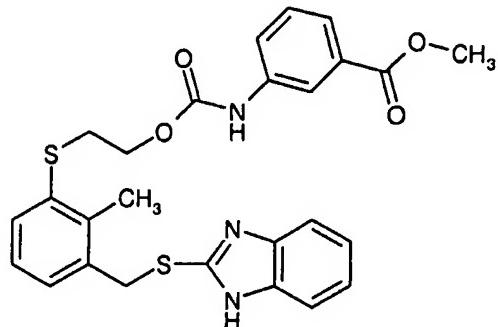


15 Mass spec' molecular ion: M+H= 464

- 20 -

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl  
benzylcarbamate

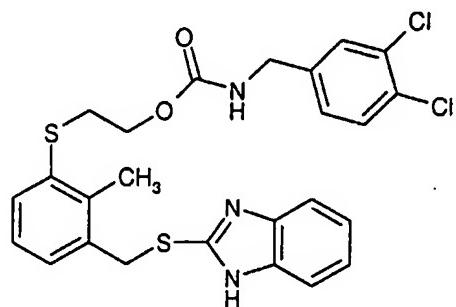
**Compound 17**



5 Mass spec' molecular ion: M+H= 508

methyl 3-({[2-(3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-ethoxy]carbonyl}amino)benzoate

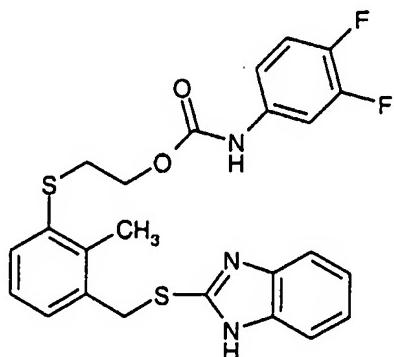
**Compound 18**



10 Mass spec' molecular ion: M+H= 532

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl 3,4-dichlorobenzylcarbamate

**Compound 19**

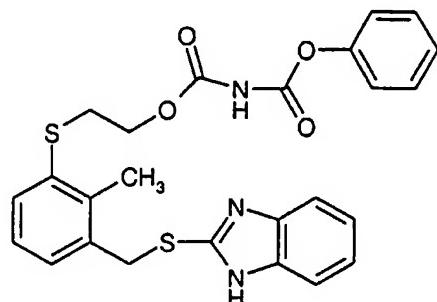


- 21 -

Mass spec' molecular ion: M+H= 486

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,4-difluorophenylcarbamate

**Compound 20**

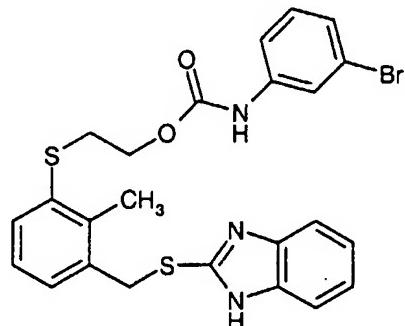


5

Mass spec' molecular ion: M+H= 494

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenyl dicarbonimidoate

**Compound 21**

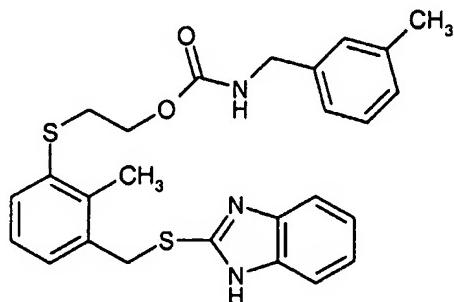


10

Mass spec' molecular ion: M+H= 529

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-bromophenylcarbamate

**Compound 22**



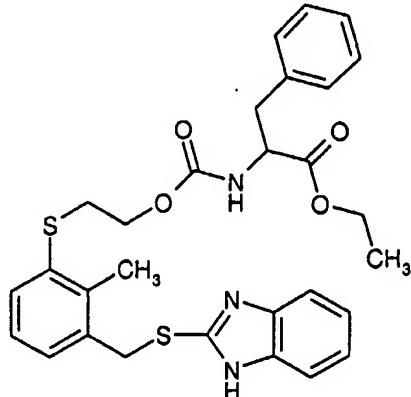
15

- 22 -

Mass spec' molecular ion: M+H= 478

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl 3-methylbenzylcarbamate

**Compound 23**

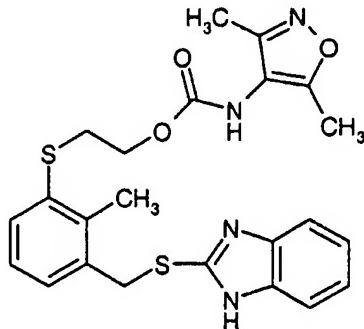


5

Mass spec' molecular ion: M+H= 550

ethyl 2-({[2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethoxy]carbonyl}amino)-3-phenylpropanoate

**Compound 24**



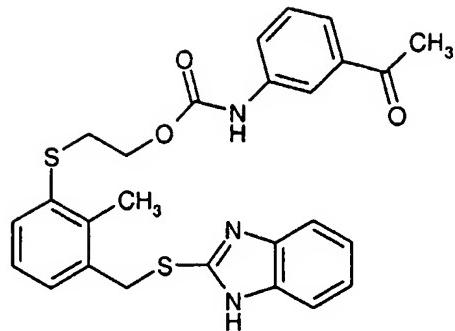
10

Mass spec' molecular ion: M+H= 469

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl 3,5-dimethyl-4-isoxazolylcarbamate

**Compound 25**

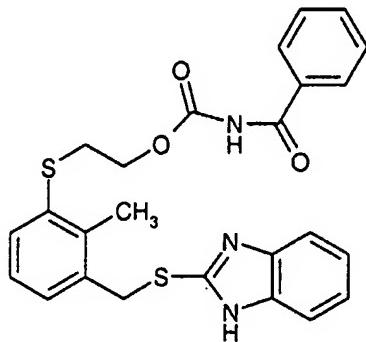
- 23 -



Mass spec' molecular ion: M+H= 492

2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-acetylphenylcarbamate

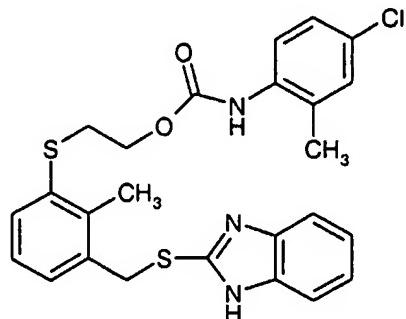
##### 5 Compound 26



Mass spec' molecular ion: M+H= 478

2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl benzoylcarbamate

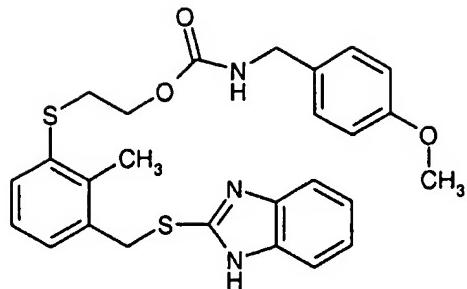
##### 10 Compound 27



Mass spec' molecular ion: M+H= 499

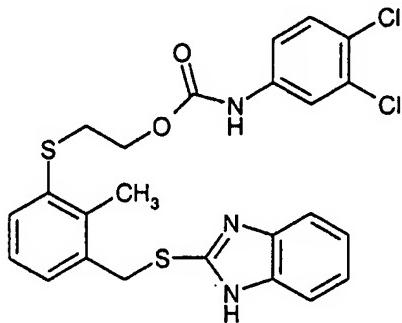
2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-chloro-2-methylphenylcarbamate

- 24 -

**Compound 28**

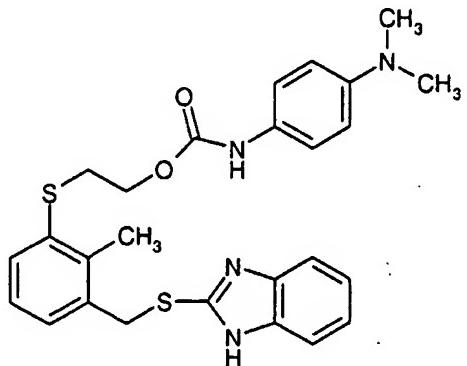
Mass spec' molecular ion: M+H= 494

2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-methoxybenzylcarbamate  
5

**Compound 29**

Mass spec' molecular ion: M+H= 518

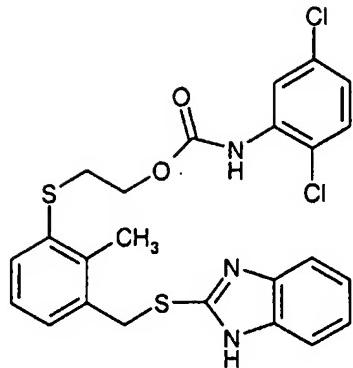
2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,4-dichlorophenylcarbamate  
10

**Compound 30**

Mass spec' molecular ion: M+H= 493

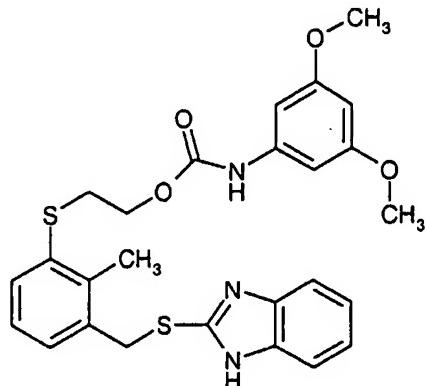
2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl  
15 4-(dimethylamino)phenylcarbamate

- 25 -

**Compound 31**

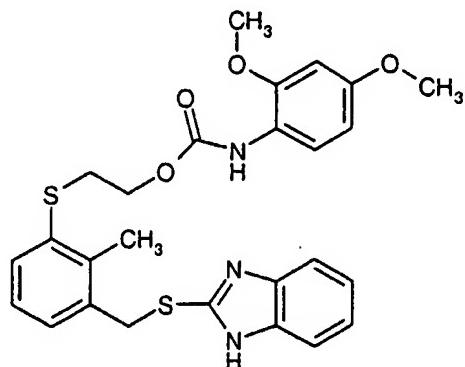
Mass spec' molecular ion: M+H= 518

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl 2,5-dichlorophenylcarbamate  
5

**Compound 32**

Mass spec' molecular ion: M+H= 510

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl 3,5-dimethoxyphenylcarbamate  
10

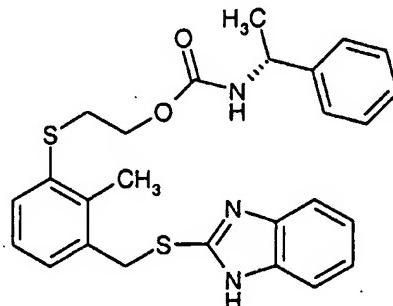
**Compound 33**

- 26 -

Mass spec' molecular ion: M+H= 510

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl 2,4-dimethoxyphenylcarbamate

**Compound 34**

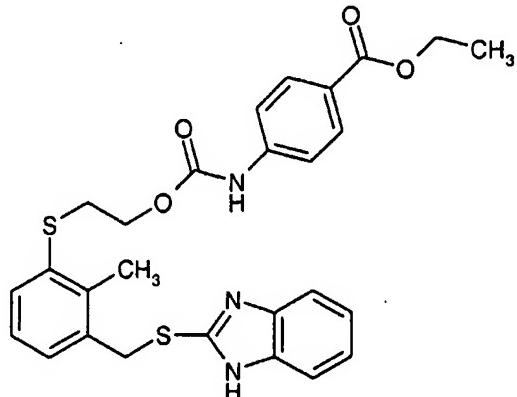


5

Mass spec' molecular ion: M+H= 478

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl (1*R*)-1-phenylethylcarbamate

**Compound 35**



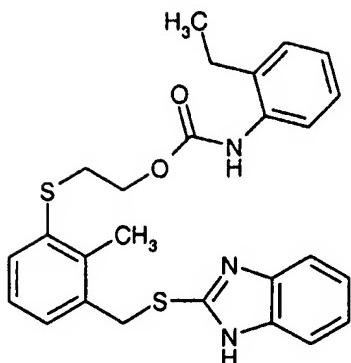
10

Mass spec' molecular ion: M+H= 522

ethyl 4-({[2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethoxy]carbonyl}amino)benzoate

**Compound 36**

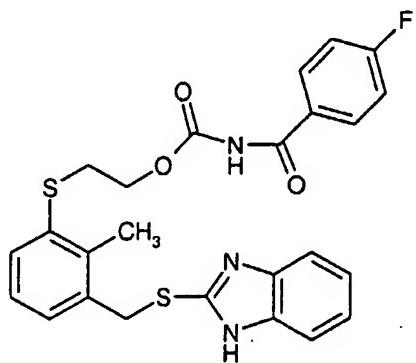
- 27 -



Mass spec' molecular ion: M+H= 478

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl 2-ethylphenylcarbamate

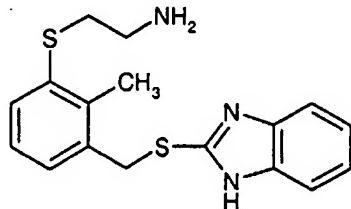
### 5 Compound 37



Mass spec' molecular ion: M+H= 496

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl 4-fluorobenzoylcarbamate

### 10 Compound 38

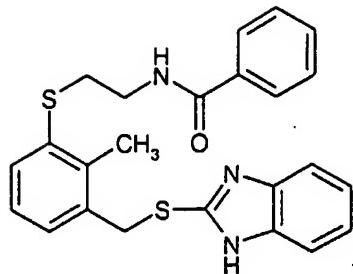


Mass spec' molecular ion: M+H= 330

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethylamine

### Compound 39

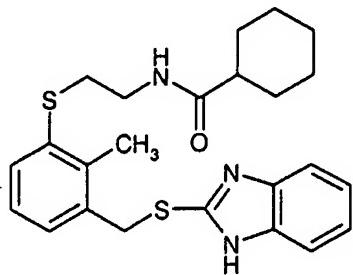
- 28 -



Mass spec' molecular ion: M+H= 434

*N*-[2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl]ethylbenzamide

**Compound 40**

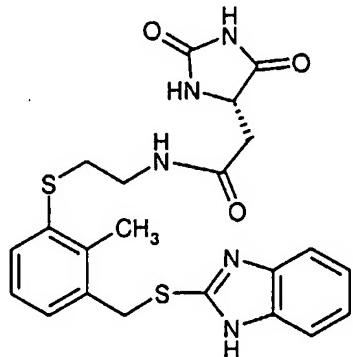


5

Mass spec' molecular ion: M+H= 440

*N*-[2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl]ethylcyclohexanecarboxamide

**Compound 41**



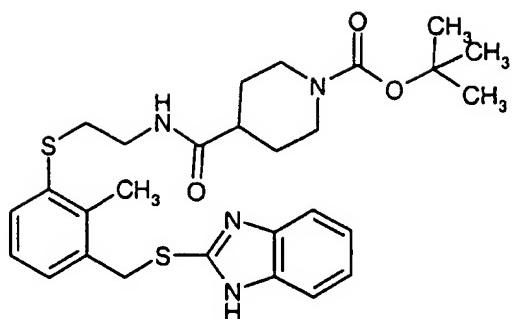
10

Mass spec' molecular ion: M+H= 470

*N*-[2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl]ethyl]-2-[(4*S*)-2,5-dioxoimidazolidinyl]acetamide

15    **Compound 42**

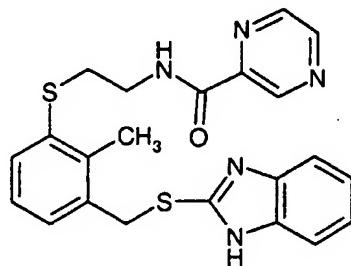
- 29 -



Mass spec' molecular ion: M+H= 541

*tert*-butyl 4-((2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl)amino)carbonyl)-1-piperidinecarboxylate

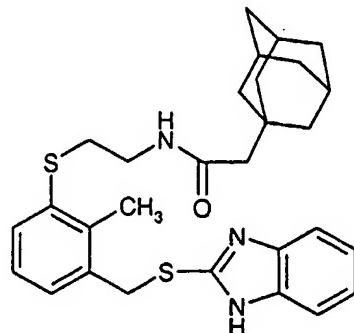
### 5 Compound 43



Mass spec' molecular ion: M+H= 436

N-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-pyrazinecarboxamide

### 10 Compound 44

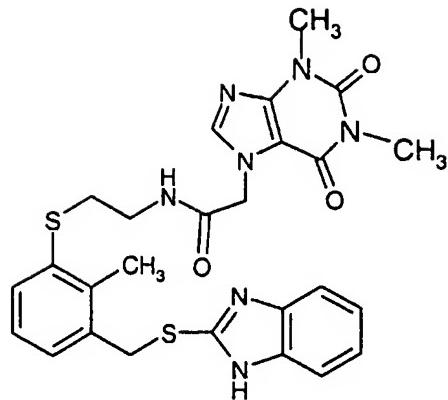


Mass spec' molecular ion: M+H= 506

2-(1-adamantyl)-N-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]acetamide

### 15 Compound 45

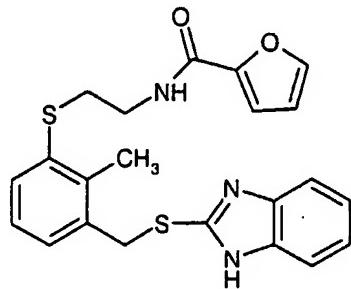
- 30 -



Mass spec' molecular ion: M+H= 550

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-(1,3-dimethyl-2,6-dioxo-1,2,3,6-tetrahydro-7*H*-purin-7-yl)acetamide

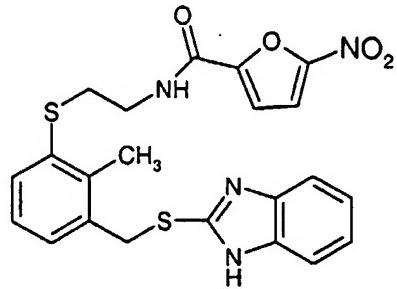
### 5 Compound 46



Mass spec' molecular ion: M+H= 424

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-furamide

### Compound 47



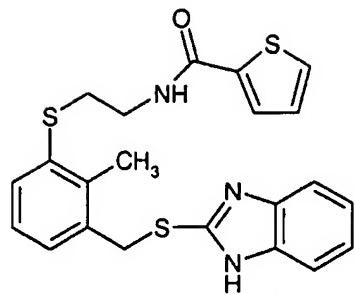
10

Mass spec' molecular ion: M+H= 469

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-5-nitro-2-furamide

### Compound 48

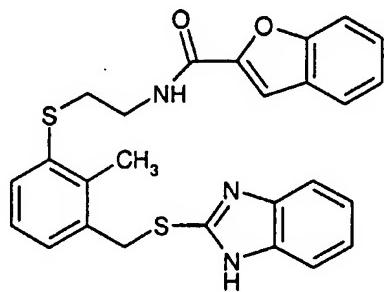
- 31 -



Mass spec' molecular ion:  $\text{M}+\text{H}= 440$

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-thiophenecarboxamide

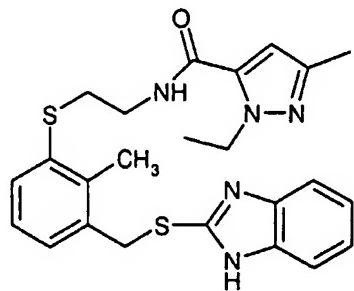
### 5 Compound 49



Mass spec' molecular ion:  $\text{M}+\text{H}= 474$

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-1-benzofuran-2-carboxamide

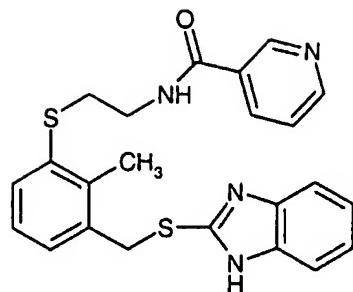
### 10 Compound 50



Mass spec' molecular ion:  $\text{M}+\text{H}= 466$

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-1-ethyl-3-methyl-1*H*-pyrazole-5-carboxamide

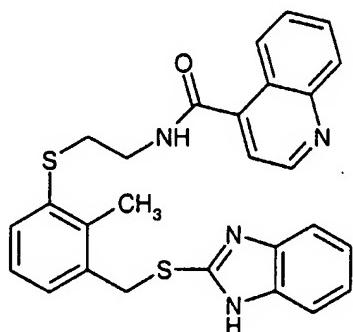
- 32 -



Mass spec' molecular ion: M+H= 435

*N*-[2-(*{*3-[(*1H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl*}*sulfanyl)ethyl]nicotinamide

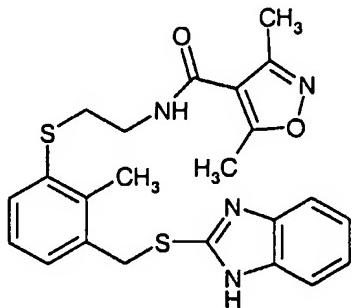
## 5 Compound 52



Mass spec' molecular ion: M+H= 485

*N*-[2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl]-4-quinolinecarboxamide

## 10 Compound 53

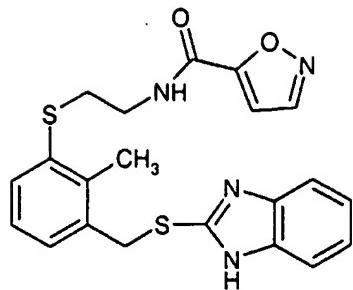


Mass spec' molecular ion: M+H= 453

*N*-[2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl]-3,5-dimethyl-4-isoxazolecarboxamide

## 15 Compound 54

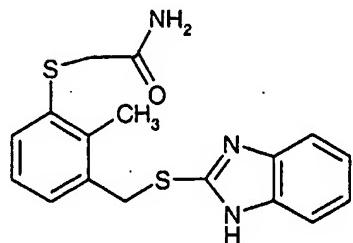
- 33 -



Mass spec' molecular ion: M+H= 425

*N*-[2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl]ethyl]-5-isoxazolecarboxamide

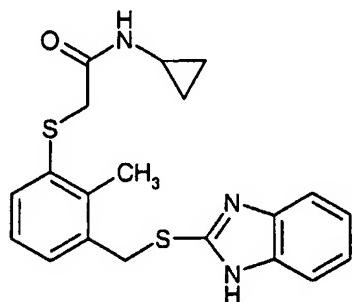
### 5 Compound 55



Mass spec' molecular ion: M+H= 344

2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanylacetamide

### Compound 56

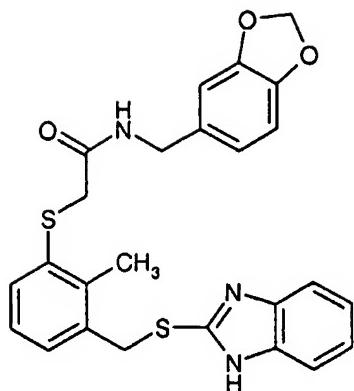


10

Mass spec' molecular ion: M+H= 384

2-(3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-cyclopropylacetamide

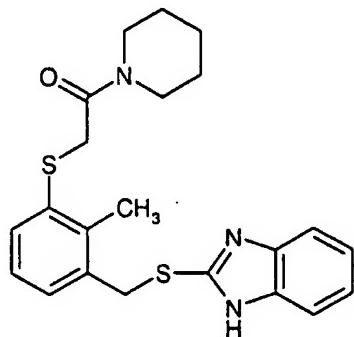
### Compound 57



Mass spec' molecular ion: M+H= 478

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(1,3-benzodioxol-5-ylmethyl)acetamide

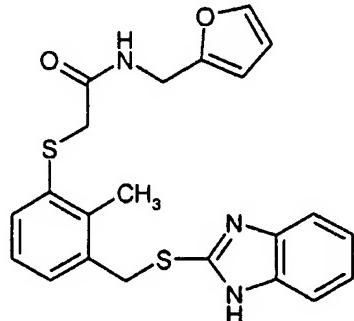
### 5 Compound 58



Mass spec' molecular ion: M+H= 412

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-(1-piperidinyl)-1-ethanone

### 10 Compound 59

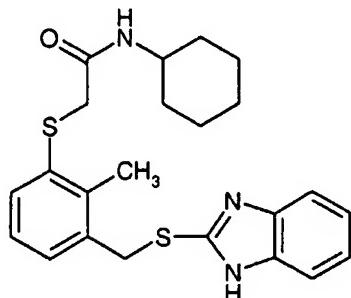


Mass spec' molecular ion: M+H= 424

- 35 -

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2-furylmethyl)acetamide

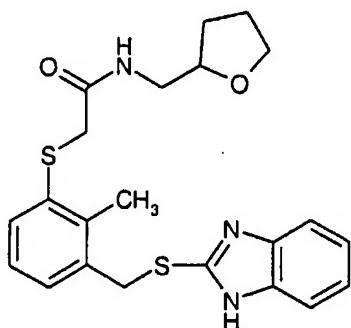
**Compound 60**



5 Mass spec' molecular ion: M+H= 426

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-cyclohexylacetamide

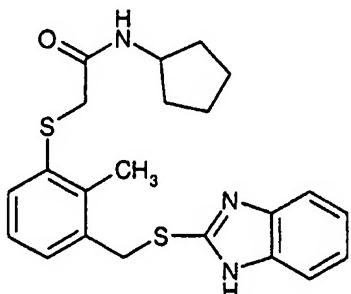
**Compound 61**



10 Mass spec' molecular ion: M+H= 428

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(tetrahydro-2-furylmethyl)acetamide

**Compound 62**

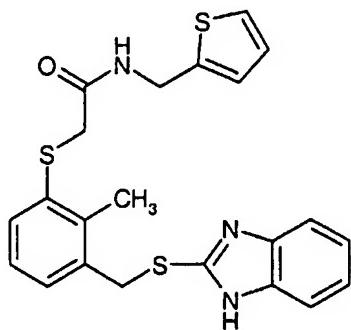


15 Mass spec' molecular ion: M+H= 412

- 36 -

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-cyclopentylacetamide

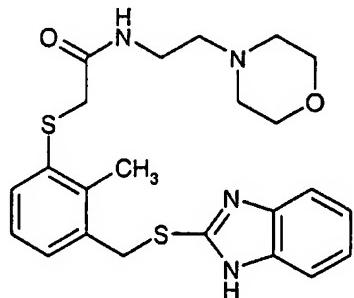
**Compound 63**



5 Mass spec' molecular ion: M+H= 440

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2-thienylmethyl)acetamide

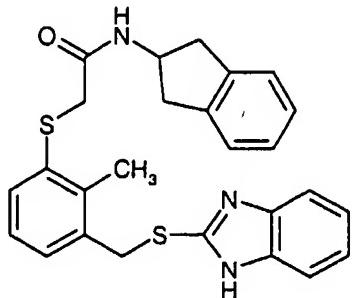
**Compound 64**



10 Mass spec' molecular ion: M+H= 457

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-[2-(4-morpholinyl)ethyl]acetamide

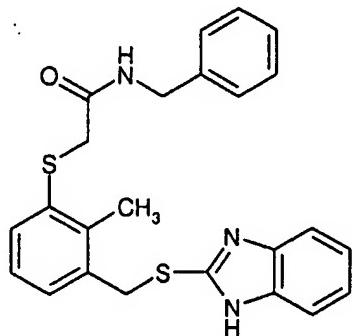
**Compound 65**



15 Mass spec' molecular ion: M+H= 460

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-*N*-(2,3-dihydro-1*H*-inden-2-yl)acetamide

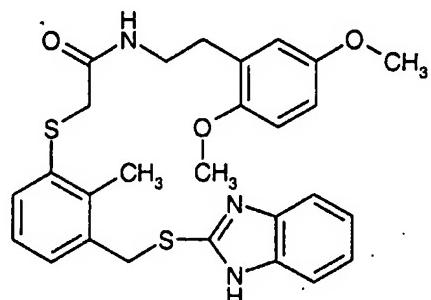
**Compound 66**



5 Mass spec' molecular ion: M+H= 434

2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-*N*-benzylacetamide

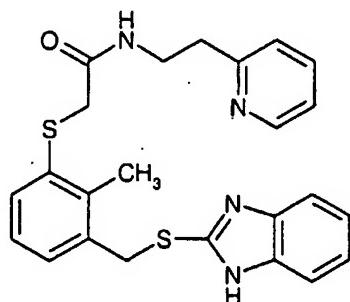
**Compound 67**



Mass spec' molecular ion: M+H= 508

10 2-({3-[{(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-*N*-(2,5-dimethoxyphenethyl)acetamide

**Compound 68**

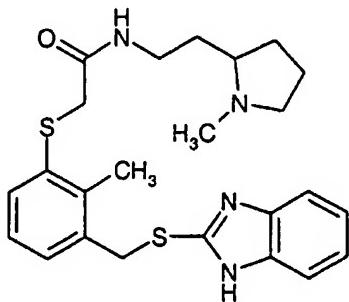


NMR:

<sup>1</sup>H NMR (dmso-d6) ppm 2.42 (s, 3H), 2.71 (m, 2H), 3.77 (s, 2H), 4.37 (m, 2H), 4.62 (s, 2H), 7.10-7.16 (m, 7H), 7.56 (m, 1H), 7.66 (m, 1H), 8.49 (m, 1H), 8.75 (m, 1H), 12.61 (s, 1H, NH).

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2-(5 pyridinyl)ethyl)acetamide

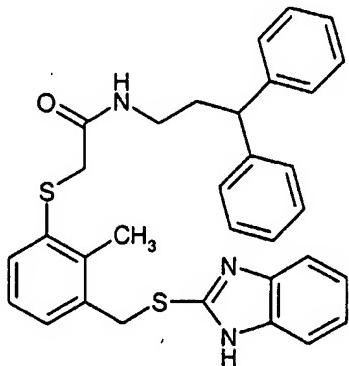
**Compound 69**



Mass spec' molecular ion: M+H= 455

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2-(1-methyl-2-pyridinyl)ethyl)acetamide

**Compound 70**

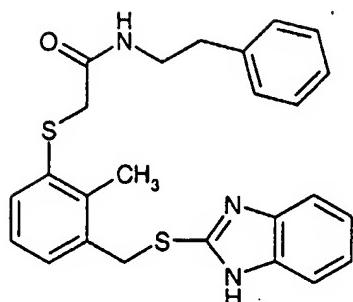


Mass spec' molecular ion: M+H= 538

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(3,3-diphenylpropyl)acetamide

**Compound 71**

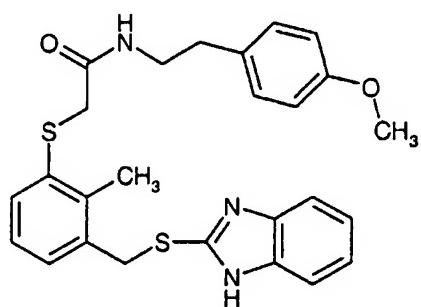
- 39 -



Mass spec' molecular ion: M+H= 449

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-phenethylacetamide

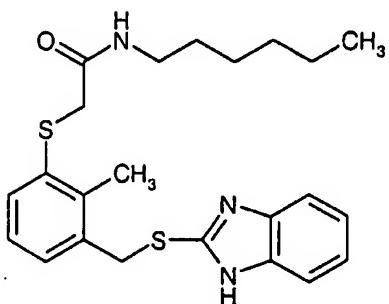
##### 5 Compound 72



Mass spec' molecular ion: M+H= 479

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(4-methoxyphenethyl)acetamide

##### 10 Compound 73

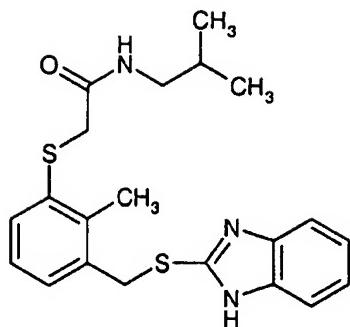


Mass spec' molecular ion: M+H= 429

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-hexylacetamide

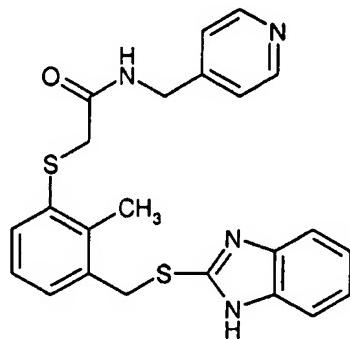
##### Compound 74

- 40 -



Mass spec' molecular ion: M+H= 401

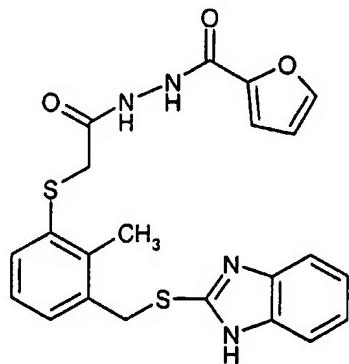
2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)-N-isobutylacetamide

**Compound 75**

5

Mass spec' molecular ion: M+H= 436

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)-N-(4-pyridinylmethyl)acetamide

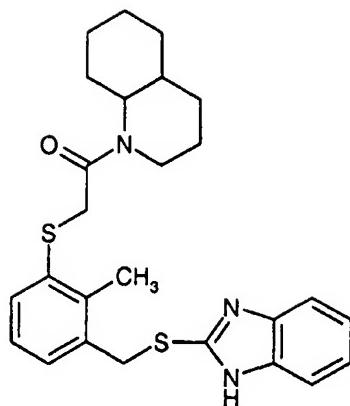
**Compound 76**

10

N-[2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)acetyl]-2-furohydrazide

**Compound 77**

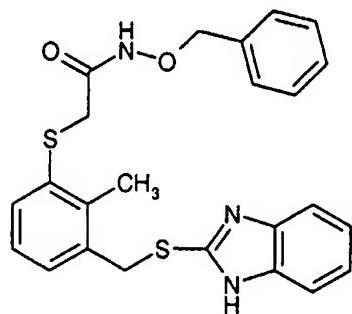
- 41 -



Mass spec' molecular ion: M+H= 467

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-1-octahydro-1(*2H*)-quinolinyl-1-ethanone

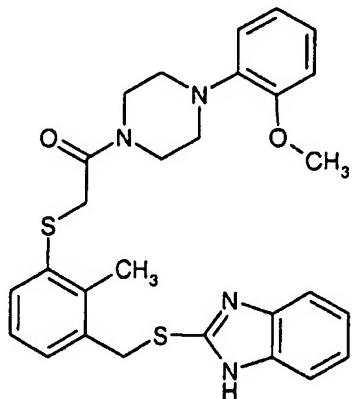
### 5 Compound 78



Mass spec' molecular ion: M+H= 450

2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-*N*-(benzyloxy)acetamide

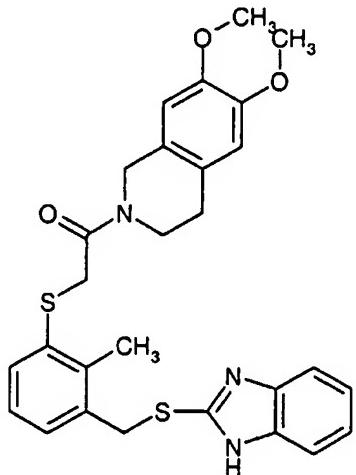
### 10 Compound 79



Mass spec' molecular ion: M+H= 519

2-(*{(1H-benzimidazol-2-ylsulfanyl)methyl}-2-methylphenyl}sulfanyl)-1-[4-(2-methoxyphenyl)-1-piperazinyl]-1-ethanone*

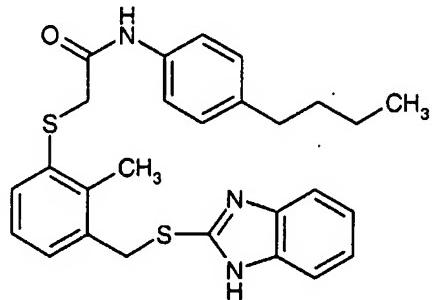
**Compound 80**



5 Mass spec' molecular ion: M+H= 521

2-(*{(1H-benzimidazol-2-ylsulfanyl)methyl}-2-methylphenyl}sulfanyl)-1-[6,7-dimethoxy-3,4-dihydro-2(*1H*)-isoquinolinyl]-1-ethanone*

**Compound 81**

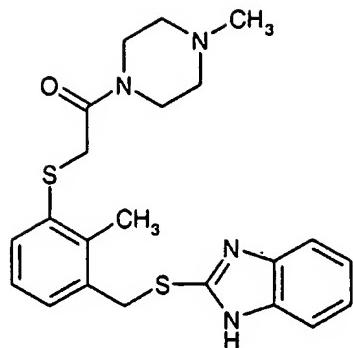


10 Mass spec' molecular ion: M+H= 477

2-(*{(1H-benzimidazol-2-ylsulfanyl)methyl}-2-methylphenyl}sulfanyl)-N-(4-butylphenyl)acetamide*

**Compound 82**

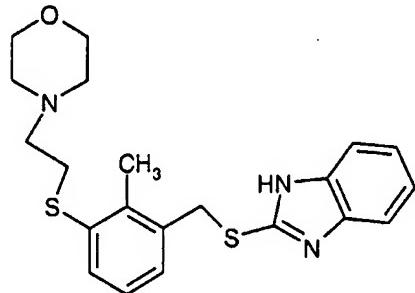
- 43 -



Mass spec' molecular ion: M+H= 427

2-((3-((1H-benzimidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)-1-(4-methyl-1-piperazinyl)-1-ethanone

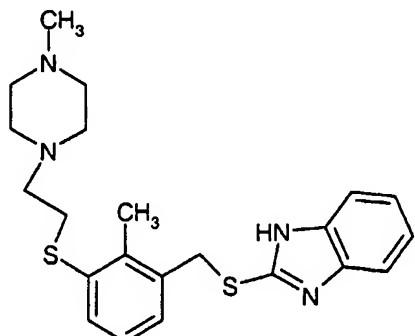
### 5 Compound 83



Mass spec' molecular ion: M+H= 400

2-[(2-methyl-3-((2-(4-morpholinyl)ethyl)sulfanyl)benzyl)sulfanyl]-1H-benzimidazole

### Compound 84



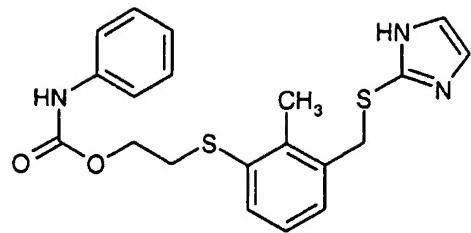
10

Mass spec' molecular ion: M+H= 413

2-[(2-methyl-3-((2-(4-methyl-1-piperazinyl)ethyl)sulfanyl)benzyl)sulfanyl]-1H-benzimidazole

### Compound 85

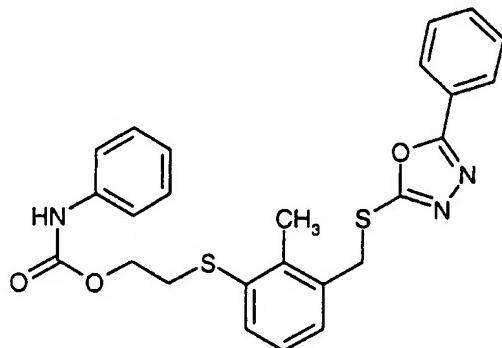
- 44 -



Mass spec' molecular ion: M+H= 400

2-((3-((1*H*-imidazol-2-ylsulfanyl)methyl)-2-methylphenyl)sulfanyl)ethyl phenylcarbamate

**Compound 86**

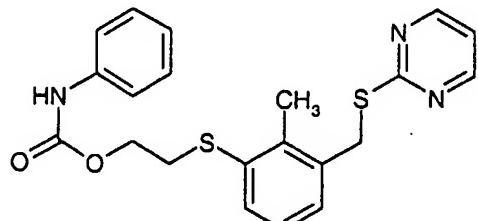


5

Mass spec' molecular ion: M+H= 478

2-[(2-methyl-3-((5-phenyl-1,3,4-oxadiazol-2-yl)sulfanyl)methyl)phenyl]sulfanyl)ethyl phenylcarbamate

**Compound 87**



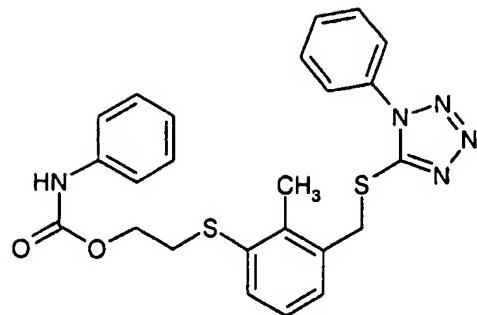
10

Mass spec' molecular ion: M+H= 412

2-((2-methyl-3-((2-pyrimidinylsulfanyl)methyl)phenyl)sulfanyl)ethyl phenylcarbamate

**Compound 88**

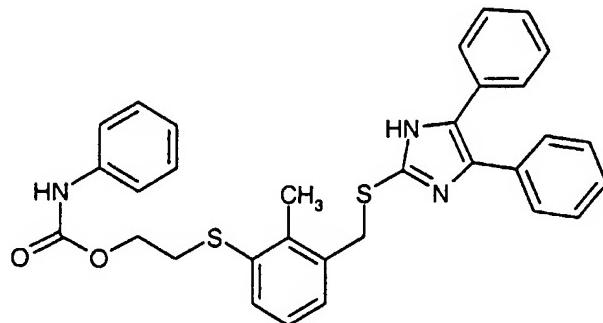
- 45 -



Mass spec' molecular ion: M+H= 478

2-[(2-methyl-3-{{(1-phenyl-1*H*-1,2,3,4-tetrazol-5-yl)sulfanyl}methyl}phenyl)sulfanyl]ethyl phenylcarbamate

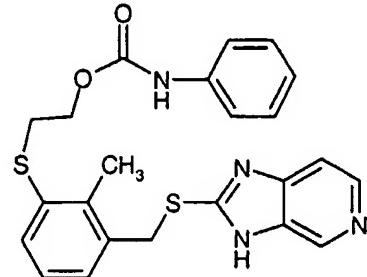
##### 5 Compound 89



Mass spec' molecular ion: M+H= 552

2-[(3-{{(4,5-diphenyl-1*H*-imidazol-2-yl)sulfanyl}methyl}-2-methylphenyl)sulfanyl]ethyl phenylcarbamate

##### 10 Compound 90

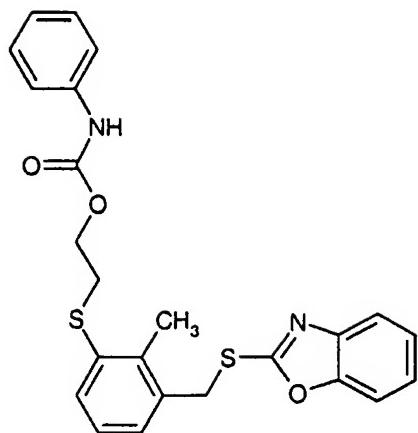


Mass spec' molecular ion: M+H= 451

2-({3-[(3*H*-imidazo[4,5-*c*]pyridin-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethyl phenylcarbamate

##### 15 Compound 91

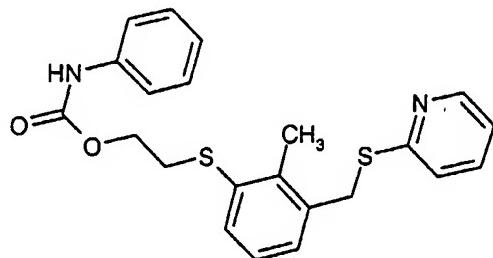
- 46 -



Mass spec' molecular ion: M+H= 451

2-((3-[(1,3-benzoxazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate

**Compound 92**

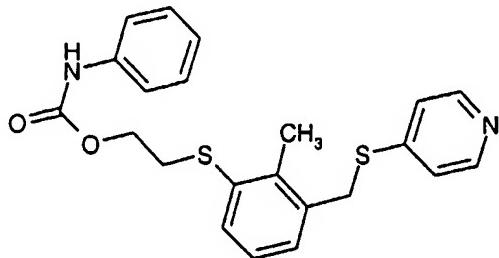


5

Mass spec' molecular ion: M+H= 411

2-((2-methyl-3-[(2-pyridinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate

**Compound 93**

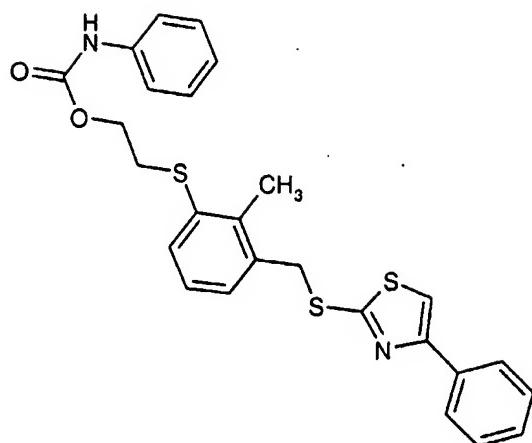


10 Mass spec' molecular ion: M+H= 411

2-((2-methyl-3-[(4-pyridinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate

**Compound 94**

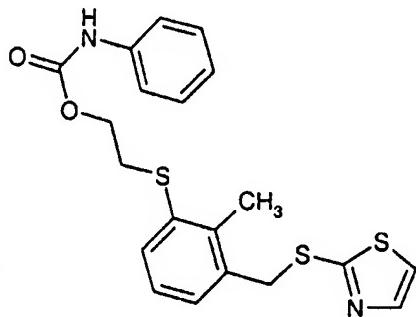
- 47 -



Mass spec' molecular ion:  $M+H= 493$

2-[(2-methyl-3-{{(4-phenyl)-1,3-thiazol-2-yl}sulfanyl}methyl]phenyl)sulfanyl]ethyl phenylcarbamate

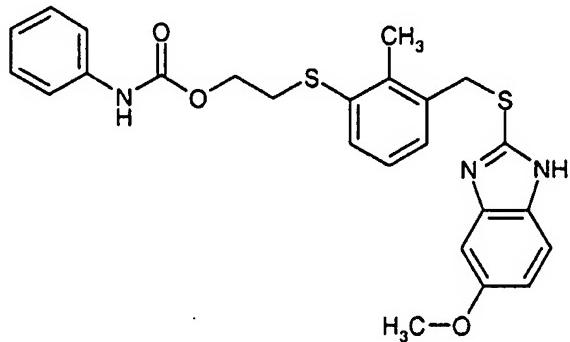
### 5 Compound 95



Mass spec' molecular ion:  $M+H= 417$

2-({2-methyl-3-[(1,3-thiazol-2-ylsulfanyl)methyl]phenyl}sulfanyl)ethyl phenylcarbamate

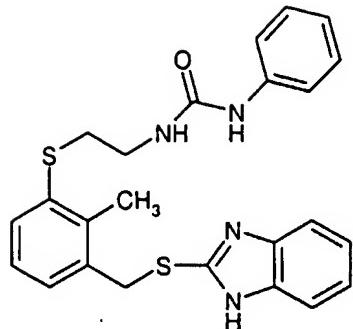
### Compound 96



10

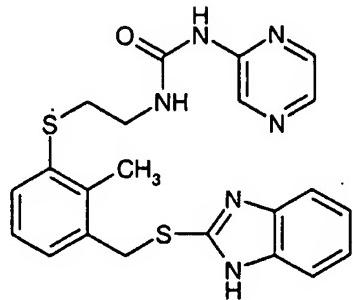
Mass spec' molecular ion:  $M+H= 480$

2-{{(3-{{(5-methoxy-1*H*-benzimidazol-2-yl)sulfanyl}methyl}-2-methylphenyl)sulfanyl}ethyl phenylcarbamate

**Compound 97**

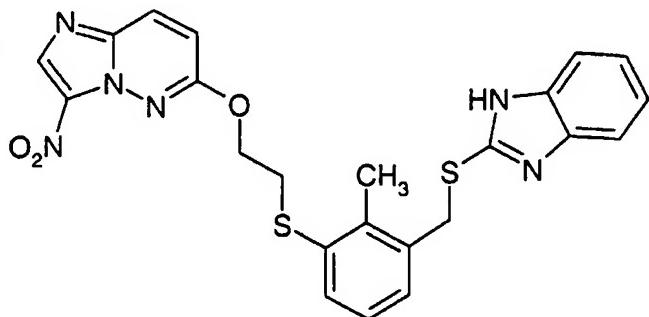
Mass spec' molecular ion: M+H= 449

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-*N'*-phenylurea  
5

**Compound 98**

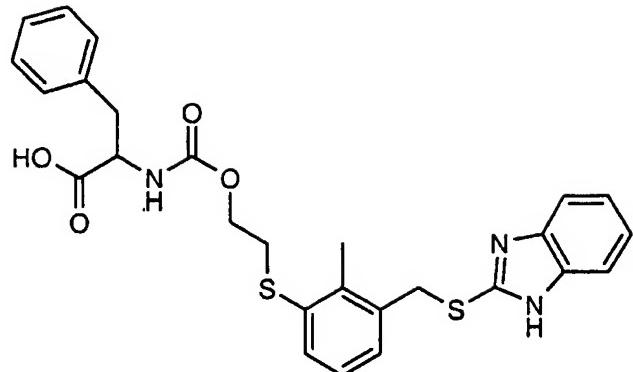
Mass spec' molecular ion: M+H= 451

*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-*N'*-(2-pyrazinyl)urea  
10

**Compound 99**

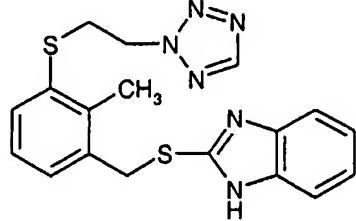
Mass spec' molecular ion: M+H= 493

6-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]-3-  
15 nitroimidazo[1,2-*b*]pyridazine

**Compound 100**

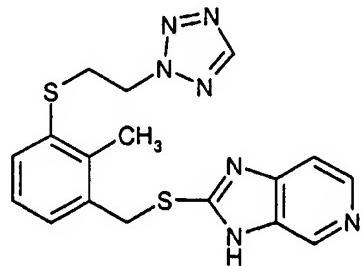
Mass spec' molecular ion: M+H= 522

- 5    *N-[(2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-*methylphenyl)sulfanyl)ethoxy]carbonyl}phenylalanine

**Compound 101**

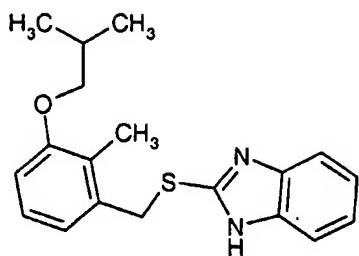
Mass spec' molecular ion: M+H= 383

- 10    2-[(2-methyl-3-[(2-(2*H*-1,2,3,4-tetrazol-2-yl)ethyl]sulfanyl)benzyl)sulfanyl]-1*H*-benzimidazole

**Compound 102**

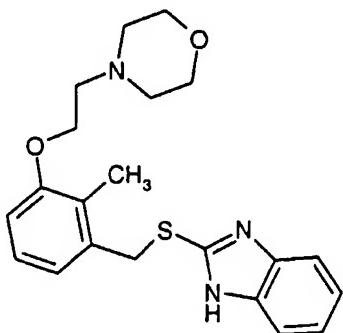
Mass spec' molecular ion: M+H= 384

- 15    2-[(2-methyl-3-[(2-(2*H*-1,2,3,4-tetrazol-2-yl)ethyl]sulfanyl)benzyl)sulfanyl]-3*H*-imidazo[4,5-*c*]pyridine

**Compound 103****NMR:**

400 MHz  $^1\text{H-NMR}$  ( $\text{CHCl}_3\text{-}d$ ) ppm 1.03 (d, 6H), 2.10 (m, 1H), 2.29 (s, 3H), 3.70 (d, 5 H), 4.56 (s, 2H), 6.75 (d, 1H), 6.90 (d, 1H), 7.05 (t, 1H), 7.20 (t, 1H), 7.21 (t, 1H), 7.29 (d, 1H), 7.70 (d, 1H).

2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole

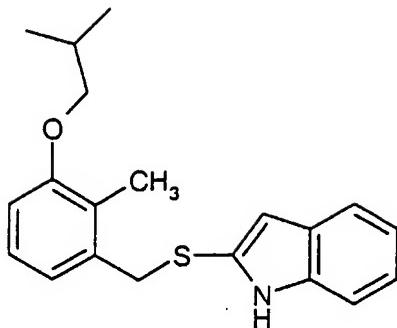
**Compound 104****10 NMR:**

500 MHz  $^1\text{H-NMR}$  ( $\text{CHCl}_3\text{-}d$ ) ppm 2.30 (s, 3H), 2.65 (m, 4H), 2.87 (m, 2H), 3.75 (m, 4H), 4.13 (m, 2H), 4.60 (s, 2H), 6.80 (d, 1H), 6.97 (d, 1H), 7.09 (t, 1H), 7.19-7.30 (m, 2H), 7.33 (d, 1H), 7.74 (d, 1H).

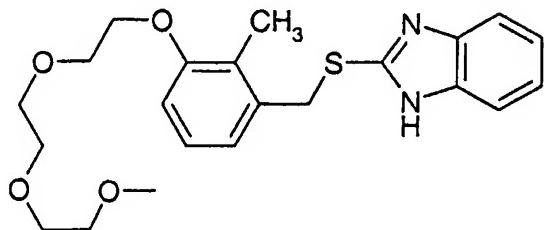
2-((2-methyl-3-(4-morpholinyl)ethoxy)benzyl)sulfanyl)-1*H*-benzimidazole

**15 Compound 105**

- 51 -

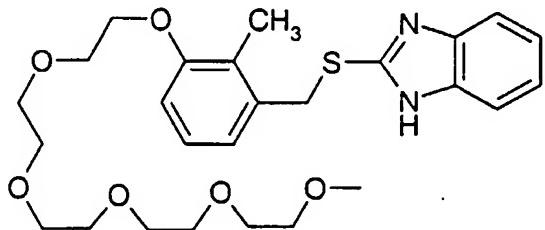


Mass spec' molecular ion: [M-H] = 324

2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-indole**Compound 106**

5

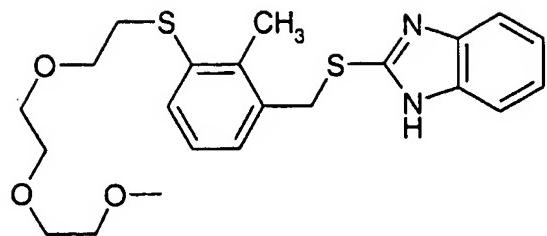
Mass spec' molecular ion: M+Na = 439

2-[(3-{2-[2-(2-methoxyethoxy)ethoxy}-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole**Compound 107**

10 Mass spec' molecular ion: M+Na = 527

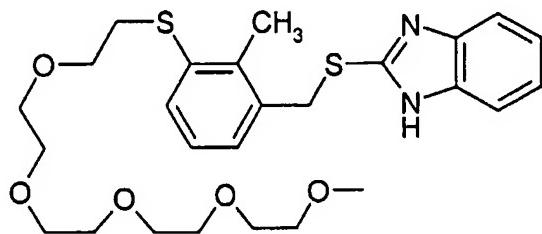
2-{{[2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-yloxy)benzyl]sulfanyl}-1*H*-benzimidazole}**Compound 108**

- 52 -

NMR:

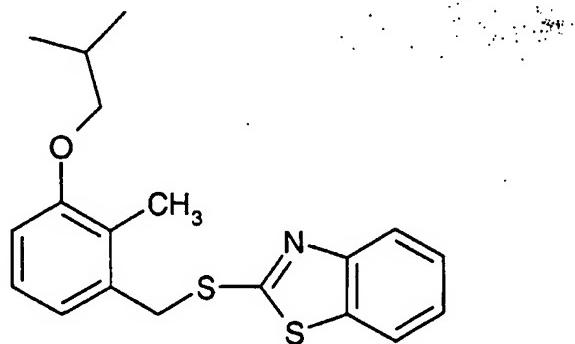
- 500 MHz  $^1\text{H}$ -NMR ( $\text{CHCl}_3-\text{d}$ ) ppm 2.43 (s, 3H), 3.02 (t, 2H), 3.35 (s, 3H), 3.52-3.55 (m, 2H), 3.56-3.68 (m, 8H), 4.55 (s, 2H), 7.01 (t, 1H), 7.12 (d, 1H), 7.19-7.23 (m, 2H),  
5 7.25 (d, 1H), 7.50-7.55 (m, 2H).

2-{{3-((2-(2-methoxyethoxy)ethoxy)ethyl)sulfanyl}-2-methylbenzyl}sulfanyl-1*H*-benzimidazole

**Compound 109**

- 10 Mass spec' molecular ion: M+Na= 543

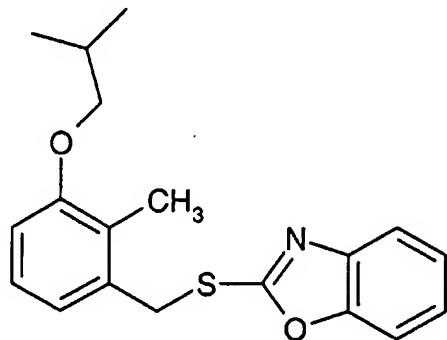
2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazole

**Compound 110**

NMR:

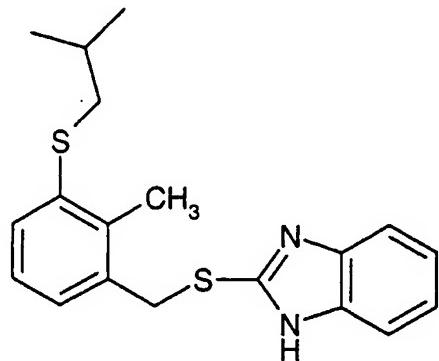
600 MHz  $^1\text{H}$ -NMR ( $\text{CHCl}_3-\delta$ ) ppm 1.05 (d, 3H), 1.06 (d, 3H), 2.15 (m, 1H), 2.34 (s, 3H), 3.73 (d, 2H), 4.65 (s, 2H), 6.79 (d, 1H), 7.02 (d, 1H), 7.11 (t, 1H), 7.31 (t, 1H), 7.44 (t, 1H), 7.77 (d, 1H), 7.92 (d, 1H).

- 5 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1,3-benzothiazole

**Compound 111**NMR:

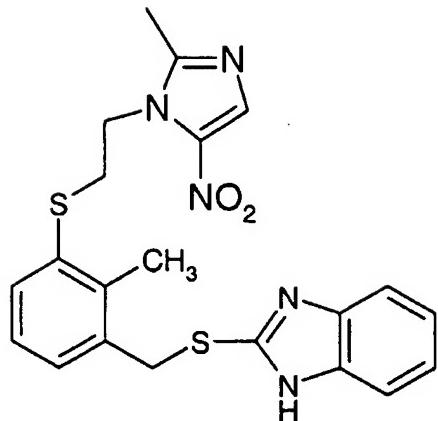
- 600 MHz  $^1\text{H}$ -NMR ( $\text{CHCl}_3-\delta$ ) ppm 1.10 (d, 6H), 2.16 (m, 1H), 2.39 (s, 3H), 3.76 (d, 2H), 4.66 (s, 2H), 6.83 (d, 1H), 7.07 (d, 1H), 7.15 (t, 1H), 7.28 (t, 1H), 7.32 (t, 1H), 7.47 (d, 1H), 7.68 (d, 1H).

## 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1,3-benzoxazole

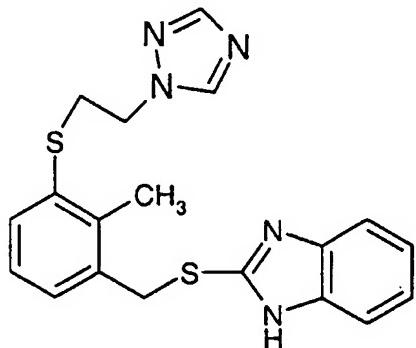
**Compound 112**

- 15 Mass spec' molecular ion:  $\text{M}+\text{H} = 343$

2-{{[3-(isobutylsulfanyl)-2-methylbenzyl]sulfanyl}-1*H*-benzimidazole}

**Compound 113**NMR:

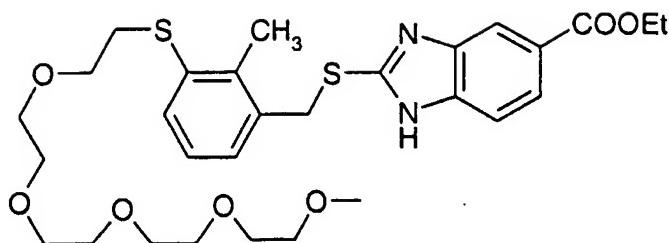
- 300 MHz  $^1\text{H-NMR}$  ( $\text{CH}_3\text{OH}-d_4$ ) ppm 2.26 (s, 3H), 2.43 (s, 3H), 3.29 (t, 2H), 4.40 (t, 2H), 4.49 (s, 2H), 4.89 (broad, >3H, exchangeable with  $\text{D}_2\text{O}$ ), 7.02 (t, 1H), 7.09-7.19 (m, 3H), 7.29 (d, 1H), 7.36-7.49 (m, 2H), 7.79 (s, 1H).
- 5 2-[(2-methyl-3-({[2-(2-methyl-5-nitro-1H-imidazol-1-yl)ethyl]sulfanyl}benzyl)sulfanyl]-1*H*-benzimidazole

**Compound 114**

10

NMR:

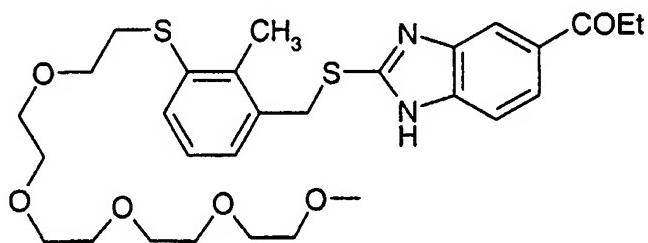
- 300 MHz  $^1\text{H-NMR}$  ( $\text{CHCl}_3-d$ ) ppm 2.37 (s, 3H), 3.28 (t, 2H), 4.30 (t, 2H), 4.43 (s, 2H), 6.86-7.00 (m, 2H), 7.10-7.22 (m, 3H), 7.32-7.72 (broad, 2H), 7.87 (s, 1H), 7.91 (s, 1H).
- 15 2-[(2-methyl-3-({[2-(1*H*-1,2,4-triazol-1-yl)ethyl]sulfanyl}benzyl)sulfanyl]-1*H*-benzimidazole

**Compound 115**

Mass spec' molecular ion: M+H= 593

ethyl 2-{[2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl]sulfanyl}-1*H*-

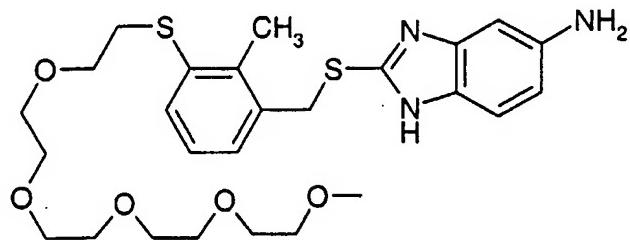
5 benzimidazole-5-carboxylate

**Compound 116**

Mass spec' molecular ion: M+Na= 599

1-(2-{[2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl]sulfanyl}-1*H*-

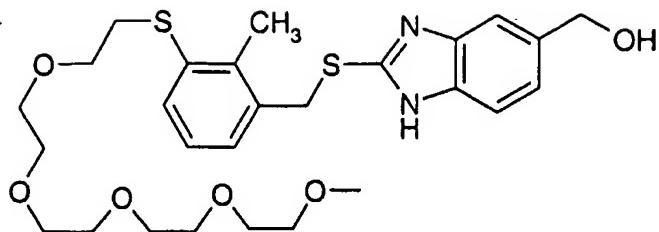
10 benzimidazol-5-yl)-1-propanone

**Compound 117**

Mass spec' molecular ion: M+Na= 558

2-{[2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl]sulfanyl}-1*H*-

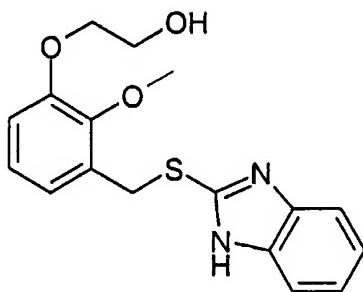
15 benzimidazol-5-amine

**Compound 118**

Mass spec' molecular ion: M+Na= 573

(2-{{[2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-

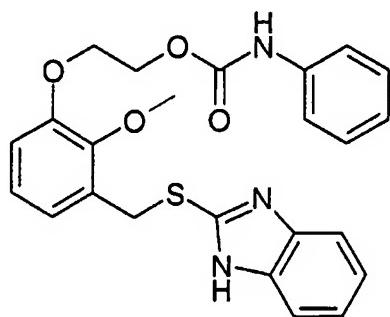
5 benzimidazol-5-yl)methanol

**Compound 119**

Mass spec' molecular ion: Mass spec' molecular ion: [M-H]<sup>-</sup> = 329

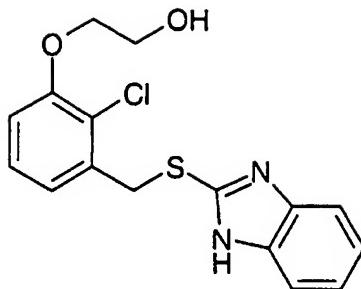
2-{{[1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methoxyphenoxy}-1-ethanol

10 **Compound 120**



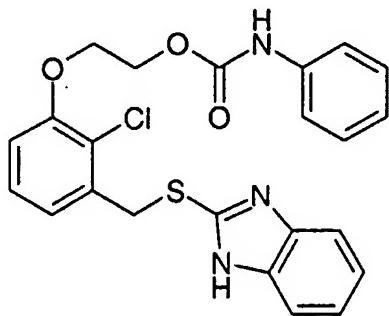
Mass spec' molecular ion: M+H= 450

2-{{[1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methoxyphenoxy}ethyl phenylcarbamate

**Compound 121**

Mass spec' molecular ion: M+H= 335

2-{3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}-1-ethanol

**5 Compound 122**

Mass spec' molecular ion: M+H= 454

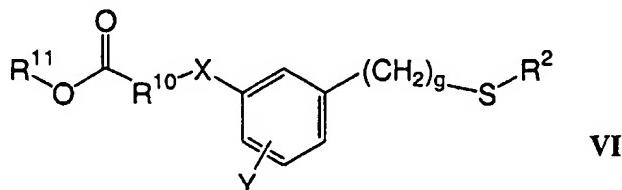
2-{3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}ethyl phenylcarbamate

10 The compounds of formula I above may be converted to a pharmaceutically-acceptable salt or solvate thereof, preferably an acid addition salt such as a hydrochloride, hydrobromide, phosphate, acetate, fumarate, maleate, tartrate, citrate, oxalate, methanesulfonate or *p*-toluenesulfonate, or an alkali metal salt such as a sodium or potassium salt.

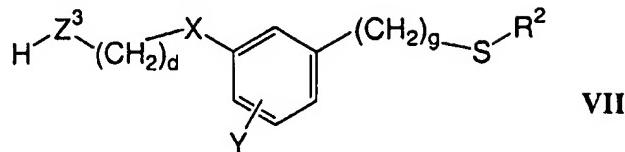
The compounds of formula I can be prepared by a process comprising any one of steps

15 (a) to (h) as follows:

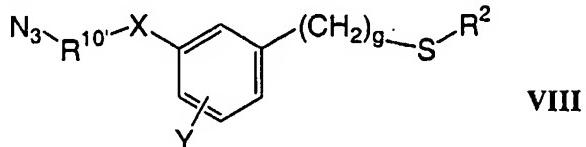
(a) reducing compound VI



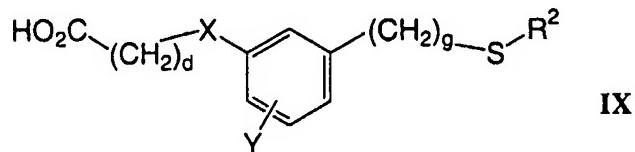
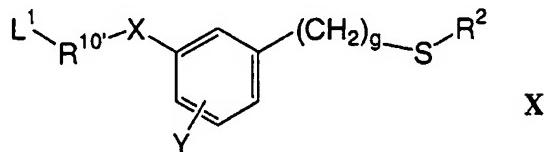
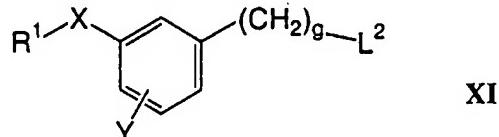
wherein  $R^{10}$  represents  $(CH_2)_d$  or  $-(CH_2)_{f-1}-O-(CH_2)_{e-}$  and  $R^{11}$  represents H or  $C_{1-6}$ alkyl; or

(b) reacting compound VII with R<sup>6</sup>-NCOwherein Z<sup>3</sup> represents O or NH; or

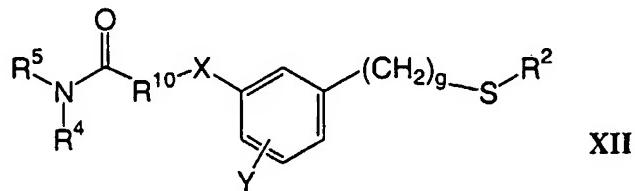
(c) reducing compound VIII



5

wherein R<sup>10</sup> represents a bond, (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-; or(d) reacting compound VII with R<sup>6</sup>-COOH; or(e) reacting compound IX with NHR<sup>4</sup>R<sup>5</sup>; or10 (f) reacting compound X with NHR<sup>4</sup>R<sup>5</sup>wherein L<sup>1</sup> represents a leaving group and R<sup>10</sup> represents (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-; or(g) reacting compound XI with R<sup>2</sup>-SH15 wherein L<sup>2</sup> represents a leaving group; or

(h) reducing compound XII

wherein R<sup>10</sup> represents (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f-1</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-.

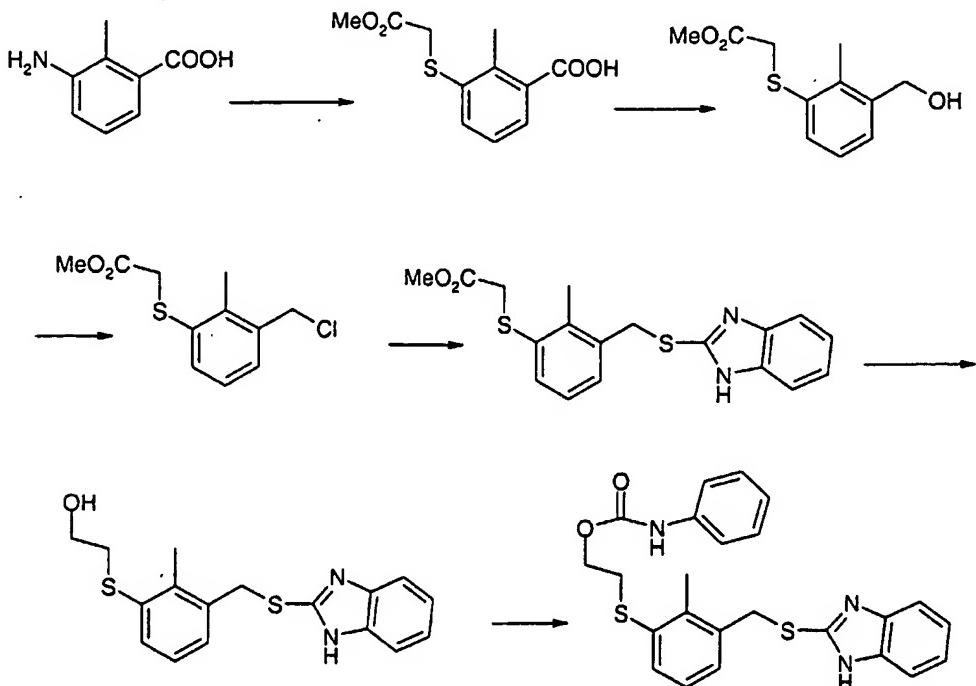
It will be appreciated by those skilled in the art that in the processes of the present invention certain functional groups such as hydroxyl or amino groups in the starting reagents or intermediate compounds may need to be protected by protecting groups. Thus, the preparation of the compounds of formula (I) may involve, at an appropriate stage, the addition 5 and subsequent removal of one or more protecting groups.

The protection and deprotection of functional groups is described in 'Protective Groups in Organic Chemistry', edited by J.W.F. McOmie, Plenum Press (1973) and 'Protective Groups in Organic Synthesis', 2nd edition, T.W. Greene and P.G.M. Wuts, Wiley-Interscience (1991).

10 The compounds of the present invention have anti-*Helicobacter pylori* activity, i.e., they can be administered to a mammalian patient therapeutically to treat *Helicobacter pylori* infection in the patient and/or to prevent such infection. A further advantage of compounds of the invention is that they are particularly selective for *Helicobacter pylori*.

### Experimental

15 **Scheme 1**



**3-[(2-Methoxy-2-oxoethyl)sulfanyl]-2-methylbenzoic acid**

3-amino-2-methylbenzoic acid, 11.3 g, was dissolved in H<sub>2</sub>O (100 mL) and conc. HCl (15 mL) was added at 0 °C. NaNO<sub>2</sub> (5.5 g) in H<sub>2</sub>O (40 mL) was added to the above

suspension over 30min. The above diazonium salt was kept at 0°C and added slowly (over 40 min) to a solution of methyl thioglycolate, 8.48 g in 50 mL of MeOH at 60 °C. During the addition, the pH of the reaction medium was kept around 5 ~ 6 by adding sat. Na<sub>2</sub>CO<sub>3</sub> very carefully. After the end of addition, the reaction was heated at 60 to 70 °C for additional

- 5 45min. The mixture was cooled to 0 °C and pH was adjusted to ~ 1 with conc. HCl & extracted with EtOAc, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated to give 17.4 g of crude 3-[(2-methoxy-2-oxoethyl)sulfanyl]-2-methylbenzoic acid.

**Methyl 2-{[3-(hydroxymethyl)-2-methylphenyl]sulfanyl}acetate**

- 3-[(2-methoxy-2-oxoethyl)sulfanyl]-2-methylbenzoic acid, 15.4 g, was dissolved in 10 120 mL THF and cooled on an ice bath. Borane-THF solution, 130 mL (1M in THF) was added slowly. The reaction was stirred for 1 hour then quenched with ice water, extracted with EtOAc, dried over Na<sub>2</sub>SO<sub>4</sub>, purified by flash chromatography (silica gel, CH<sub>2</sub>Cl<sub>2</sub>/EtOAc = 20/1) to give 5 grams of methyl 2-{[3-(hydroxymethyl)-2-methylphenyl]sulfanyl}acetate.

**Methyl 2-{[3-(chloromethyl)-2-methylphenyl]sulfanyl}acetate**

- 15 Methyl 2-{[3-(hydroxymethyl)-2-methylphenyl]sulfanyl}acetate, 4.4 g was dissolved in 220 mL methylene chloride, treated with thionyl chloride, 5 mL, and stirred at room temp. for 4 hours. The solvents were evaporated to yield 4.3 g of methyl 2-{[3-(chloromethyl)-2-methylphenyl]sulfanyl}acetate as a slightly brown oil.

**Methyl 2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)acetate**

- 20 2-mercaptopbenzimidazole, 2 g, was dissolved in a solution of 10 mL water, 30 mL methanol, and 0.53 g NaOH, and cooled on an ice bath. A solution of 3.2 g of methyl 2-{[3-(chloromethyl)-2-methylphenyl]sulfanyl}acetate in 50 mL methanol was added and the reaction was stirred at room temp. for 6 hours. The solvents were evaporated and the residue was partitioned between 600 mL CH<sub>2</sub>Cl<sub>2</sub> and 300 mL of 5% Na<sub>2</sub>CO<sub>3</sub>, the org. layer was 25 collected, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give 3.1 g methyl 2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)acetate as a light yellow solid.

**2-({3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-1-ethanol**

- Methyl 2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)acetate, 5.7 g, was dissolved in 100 mL THF and cooled on a ice-bath. 30 Lithium aluminum hydride, 0.5 g was added portion-wise under ca 5 min. After 30 min the reaction was quenched with Glauber salt(Na<sub>2</sub>SO<sub>4</sub>×10H<sub>2</sub>O). Filtration and evaporation afforded 2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)-1-ethanol, 4.1 g.

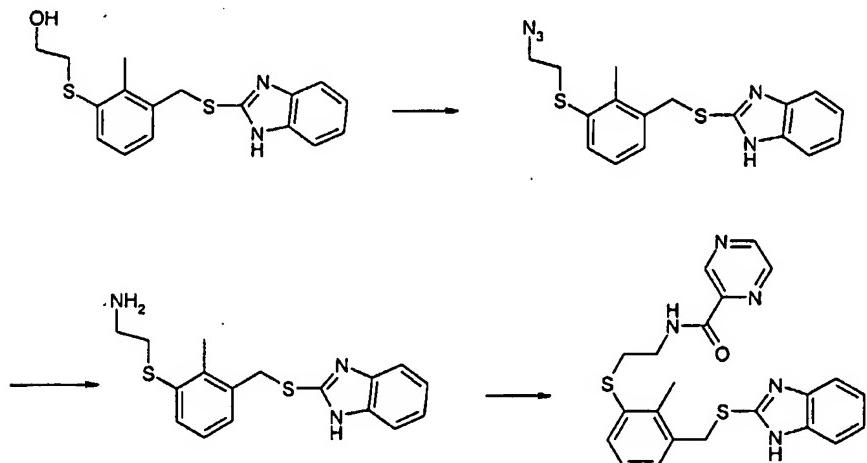
Mass spec.; M+H=331.

**2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate**

100 mg of 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanol was dissolved in 2 mL DMF, and 35 mg phenyl isocyanate was added, the mixture was stirred for 18 hours at room temp., and concentrated in vacuo. Purification by reverse phase HPLC gave 60 mg 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)-sulfanyl)ethyl phenylcarbamate as a white solid.

Mass spec.; M+H=450.

10 **Scheme 2**



**2-((3-[(2-Azidoethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole**

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanol, 0.165 g, triphenylphosphine, 0.184 g, and sodium azide, 0.13 g, were combined with stirring in 4 mL DMF on an ice bath, carbon tetrabromide, 0.25 g, was added, and the reaction was allowed to proceed for 18 hours. 20 mL methylene chloride was added, the resulting suspension was filtered, the solids were rinsed with methylene chloride and the filtrate washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, and evaporated. Purification of the residue by flash chromatography (silica gel, EtOAc/Hexane = 1:5 ) gave 2-((3-[(2-azidoethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole, 0.85 g. Mass spec.; M+H=356

**2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethylamine**

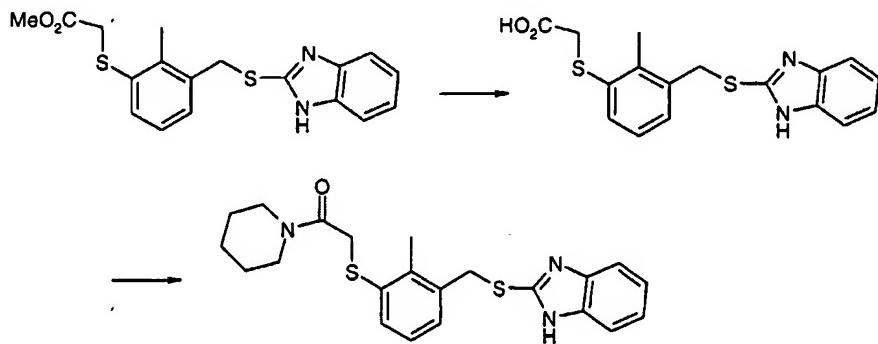
2-((3-[(2-azidoethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole, 0.42 g, was added to a suspension of 0.3 g lithium aluminum hydride in 10 mL THF over an ice bath. After 45 minutes, the reaction was quenched with Na<sub>2</sub>SO<sub>4</sub>.10H<sub>2</sub>O until H<sub>2</sub> evolution ceased.

The mixture was filtered, evaporated, dissolved in ethyl acetate and extracted with 1N HCl. The aqueous layer was washed with ethyl acetate and evaporated to give 275 mg of 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethylamine as a white solid. Mass spec.; M+H=330

5 *N*-[2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-pyrazinecarboxamide

To a solution of 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethylamine (658 mg), 2-pyrazinecarboxylic acid (248 mg), diisopropylethylamine (1 mL) and DMF (8 mL) was added HBTU (829 mg). The resulting  
10 mixture was stirred overnight. The mixture was transferred to a sep. funnel and diluted with EtOAc (200 mL) and washed with water (2 x 100 mL). The organic layer was washed with Sat. Brine, dried over MgSO<sub>4</sub>, filtered and concentrated. The crude residue was purified by reverse phase HPLC, C18 column (10-100% MeCN/H<sub>2</sub>O) to give *N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-pyrazinecarboxamide as  
15 600mg white solid. Mass spec.; M+H=436

**Scheme 3**



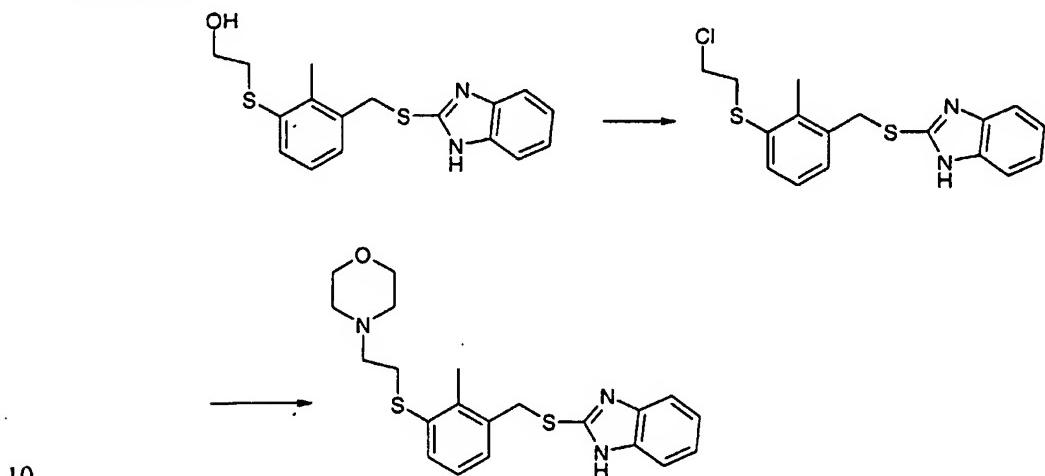
**2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)acetic acid**

Methyl 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-2-  
20 methylphenylacetate, 0.68 g, was dissolved in 14 mL MeOH and treated with excess LiOH dissolved in 2 mL H<sub>2</sub>O for 1 h. The solvents were evaporated and the residue was partitioned between 100 mL 5% Na<sub>2</sub>CO<sub>3</sub> and 100 mL EtOAc. The aq layer was collected and the pH was adjusted to about 4 with 4M HCl. The aq layer was extracted with a 2:1 ethyl acetate/THF mixture. The combined organic layers were dried over MgSO<sub>4</sub> and evaporated to  
25 leave 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)acetic acid as a white solid, 0.5 g.

**2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-(1-piperidinyl)-1-ethanone**

100 mg of 2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)acetic acid was dissolved in 2 mL of DMF, 30 mg piperidine and 120 mg of HBTU were added. The mixture was stirred for 18 hours, diluted with ethyl acetate, washed with 5% NaHCO<sub>3</sub>, saturated NaCl, dried over MgSO<sub>4</sub>, and evaporated to give 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-(1-piperidinyl)-1-ethanone, 110 mg. Mass spec.; M+H=412.

**Scheme 4**



**2-((3-[(2-Chloroethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole**

0.38 g 2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanol was combined with 5 mL CH<sub>2</sub>Cl<sub>2</sub> and cooled to 0 °C. Excess SOCl<sub>2</sub> was added. Cold bath removed. Suspension stirred at RT for 2 hours. Concentrated in vacuo, 0.39 g crude 15 2-((3-[(2-chloroethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole obtained.

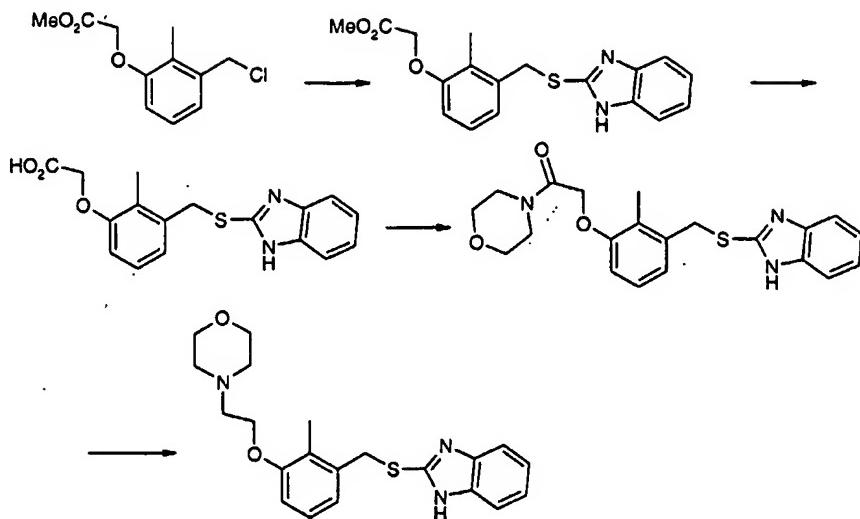
**2-[(2-methyl-3-[[2-(4-morpholinyl)ethyl]sulfanyl]benzyl)sulfanyl]-1*H*-benzimidazole**

2-((3-[(2-Chloroethyl)sulfanyl]-2-methylbenzyl)sulfanyl)-1*H*-benzimidazole, 0.202 g, 1.3 mL morpholine, 3 mL DMF, and 1 mL DMSO combined and warmed at 80 °C for 1 day. Diluted to 100 mL with ethyl acetate. Washed with water, brine (2X), dried over MgSO<sub>4</sub>, 20 evaporated to give a thick oil. Purified via preparative HPLC to give 2-[(2-methyl-3-[[2-(4-morpholinyl)ethyl]sulfanyl]benzyl)sulfanyl]-1*H*-benzimidazole as a fine powder, 0.12 g. Mass spec.; M+H=400.

Compound 113 can be prepared by a similar scheme by using 2-methyl-5-nitro-1*H*-imidazole in place of morpholine.

Compound 114 can be prepared by a similar scheme by using 1*H*-triazole in place of morpholine.

**Scheme 5**



**5 Methyl 2-{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetate**

2-Mercaptobenzimidazole, 2 g, was dissolved in a solution of 10 mL water, 30 mL methanol, and 0.53 g NaOH, and cooled on an ice bath. A solution of 3.2 g of methyl 2-[3-(chloromethyl)-2-methylphenoxy]acetate in 50 mL methanol was added and the reaction was stirred at room temp. for 6 hours. The solvents were evaporated and the residue was partitioned between 600 mL CH<sub>2</sub>Cl<sub>2</sub> and 300 mL of 5% Na<sub>2</sub>CO<sub>3</sub>, the org. layer was collected, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give 3.1 g methyl 2-{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetate as a light yellow solid.

**2-{3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetic acid**

Methyl 2-{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetate, 0.68 g, was dissolved in 14 mL MeOH and treated with excess LiOH dissolved in 2 mL H<sub>2</sub>O for 1 h. The solvents were evaporated and the residue was partitioned between 100 mL 5% Na<sub>2</sub>CO<sub>3</sub> and 100 mL EtOAc. The aq layer was collected and the pH was adjusted to about 4 with 4M HCl. The aq layer was extracted with a 2:1 ethyl acetate/THF mixture. The combined organic layers were dried over MgSO<sub>4</sub> and evaporated to leave 2-{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetic acid as a white solid, 0.5 g.

**2-{3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}-1-(4-morpholinyl)-1-ethanone**

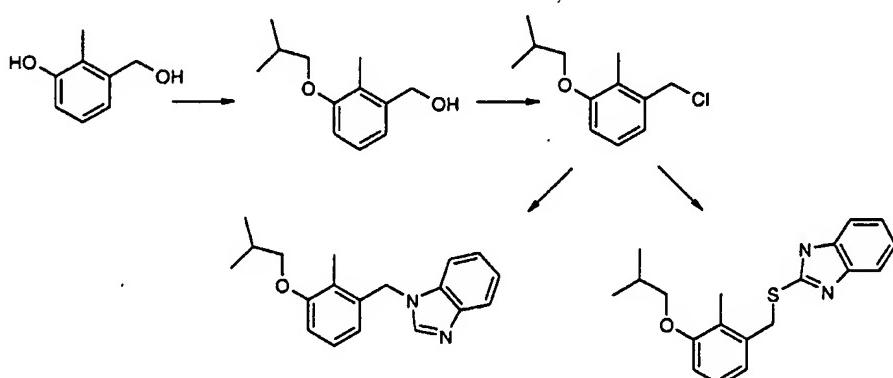
- 65 -

100 mg of 2-{[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}acetic acid was dissolved in 2 mL of DMF, 30 mg morpholine and 120 mg of HBTU were added. The mixture was stirred for 18 hours, diluted with ethyl acetate, washed with 5% NaHCO<sub>3</sub>, saturated NaCl, dried over MgSO<sub>4</sub>, and evaporated to give 2-{[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}-1-(4-morpholinyl)-1-ethanone, 110 mg.

**5 2-(2-Methyl-3-[2-(4-morpholinyl)ethoxy]benzyl)sulfanyl-1*H*-benzimidazole**

2-{[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenoxy}-1-(4-morpholinyl)-1-ethanone, 0.7 g, was dissolve in 20 mL THF. 0.2 g lithium aluminum hydride was added, and the mixtue was warmed to 70 °C for 45 minutes. Na<sub>2</sub>SO<sub>4</sub>-10H<sub>2</sub>O was added, the mixture 10 was filtered, concentrated and purified by column chromatography (SiO<sub>2</sub>, ethyl acetate) to give 2-(2-methyl-3-[2-(4-morpholinyl)ethoxy]benzyl)sulfanyl-1*H*-benzimidazole as a white foam, 0.42 g.

**Scheme 6**



**15 (3-Isobutoxy-2-methylphenyl)methanol**

2-Methyl-3-hydroxymethylphenol [prepared by lithium aluminum hydride reduction of 2-methyl-3-hydroxybenzoic acid], 1 g, isobutyl bromide, 1.6 mL, and K<sub>2</sub>CO<sub>3</sub>, 3 g, were combined in 10 mL DMF and stirred at 70 °C for 1 day. The mixture was diluted with ethyl acetate, washed with water and brine, dried over MgSO<sub>4</sub>, and evaporated to give (3-isobutoxy-20 2-methylphenyl)methanol as a yellow waxy solid, 1.15 g.

**1-(3-Isobutoxy-2-methylbenzyl)-1*H*-benzimidazole**

0.5 g (3-isobutoxy-2-methylphenyl)methanol was dissolved in 3 mL CH<sub>2</sub>Cl<sub>2</sub>, and 0.7 mL SOCl<sub>2</sub> was carefully added. The mixture was stirred for 30 min., then concentrated to give crude 1-(chloromethyl)-3-isobutoxy-2-methylbenzene. The crude chloride sample was 25 dissolved in 3 mL DMF, and 0.26 g benzimidazole and 0.6 g K<sub>2</sub>CO<sub>3</sub> were added. The

- 66 -

suspension was stirred at rt overnight. The mixture was diluted with ethyl acetate, washed with water and brine, dried over MgSO<sub>4</sub>, and evaporated to give a residue which was purified by flash chromatography, silica gel, 20-50% ethyl acetate/Hexane. 1-(3-isobutoxy-2-methylbenzyl)-1*H*-benzimidazole was thus obtained as an off-white solid, 0.6g. Mass spec.;

5 M+H=295.

#### 2-[(3-Isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole

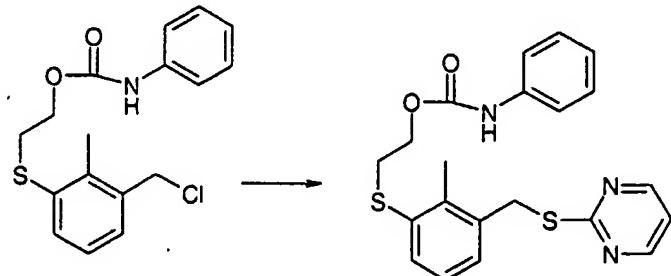
2-Mercaptobenzimidazole, 2 g, was dissolved in a solution of 10 mL water, 30 mL methanol, and 0.53 g NaOH, and cooled on an ice bath. A solution of 3.2 g 1-(chloromethyl)-3-isobutoxy-2-methylbenzene in 50 mL methanol was added and the reaction was stirred at 10 room temp. for 6 hours. The solvents were evaporated and the residue was partitioned between 600 mL CH<sub>2</sub>Cl<sub>2</sub> and 300 mL of 5% Na<sub>2</sub>CO<sub>3</sub>, the org. layer was collected, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give 3.1 g 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole as a light yellow solid.

Compound 105 can be made by a similar scheme by using 2-mercptoindole in place 15 of 2-mercaptobenzimidazole.

Compound 110 can be made by a similar scheme by using 2-mercaptopbenzothiazole in place of 2-mercaptobenzimidazole.

Compound 111 can be made by a similar scheme by using 2-mercaptopbenzoxazole in place of 2-mercaptobenzimidazole.

20 **Scheme 7**



#### 2-((2-Methyl-3-[(2-pyrimidinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate

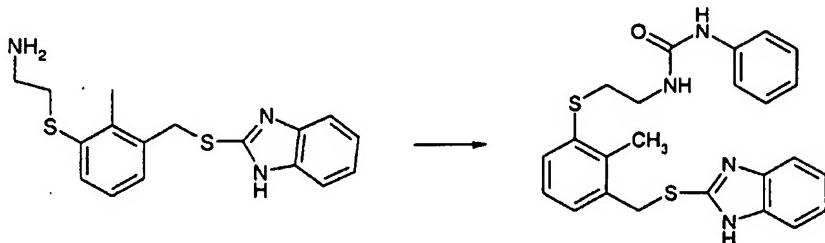
To a solution of 135 mg of 2-[(3-(chloromethyl)-2-methylphenyl)sulfanyl]ethyl phenylcarbamate in 2 mL DMF was added 65 mg of 2-thiopyrimidine, and 600 mg K<sub>2</sub>CO<sub>3</sub>.

25 The suspension was stirred vigorously at RT for 1.5 hrs. The mixture was diluted to 25 mL with ethyl acetate, washed with 15 mL water, 2 X 15mL 1N KOH, 15mL brine, and dried over MgSO<sub>4</sub>. Evaporation gave a thick oil. Purification by flash chromatography, silica gel, 10-

- 67 -

30% ethyl acetate/hexane gave 2-((2-methyl-3-[(2-pyrimidinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate as a waxy solid, 130 mg. Mass spec.; M+H=412.

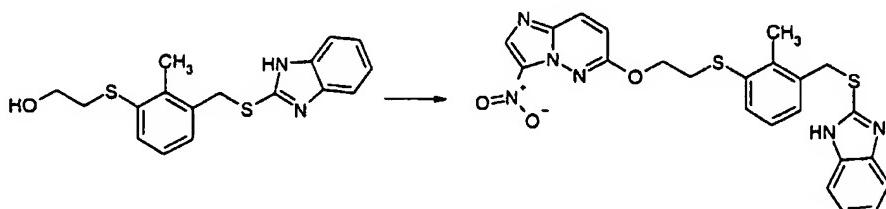
**Scheme 8**



**N-[2-((3-[(1H-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-N'-phenylurea**

100 mg of the 2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanamine was dissolved in 2 mL of DMF and 36 mg of phenyl  
10 isocyanate was added. The mixture was stirred at rt overnight. The reaction was evaporated, and the crude compound was purified by reverse phase preparative HPLC to give *N*-[2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-*N*'-phenylurea as a white powder, 85 mg. Mass spec.; M+H=449.

**Scheme 9**



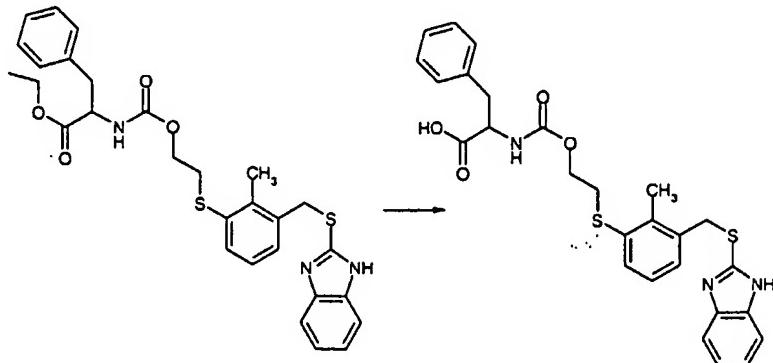
**6-[2-((3-[(1H-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]-3-nitroimidazo[1,2-b]pyridazine**

To a solution of 330 mg of 2-((3-[(1H-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanol in 30 mL DMF was added 160 mg sodium hydride (60% dispersion in oil), the suspension was stirred for 30 min, then 199 mg of 6-chloro-3-nitroimidazo[1,2-b]pyridazine (Kobe, J.; Stanovnik, B.; Tisler, Miha. *Tetrahedron* (1968), 24(1), 239) was added. After stirring the suspension overnight at rt, 5 mL water was added carefully, then the mixture was concentrated under vacuum to leave a brown solid residue. The residue was stirred with acetone and filtered, the filtrate was concentrated and the 25 resulting solids were rinsed with hot ethanol to yield 6-[2-((3-[(1H-benzimidazol-2-

- 68 -

ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethoxy]-3-nitroimidazo[1,2-*b*]pyridazine as a light brown powder, 140 mg.

**Scheme 10**

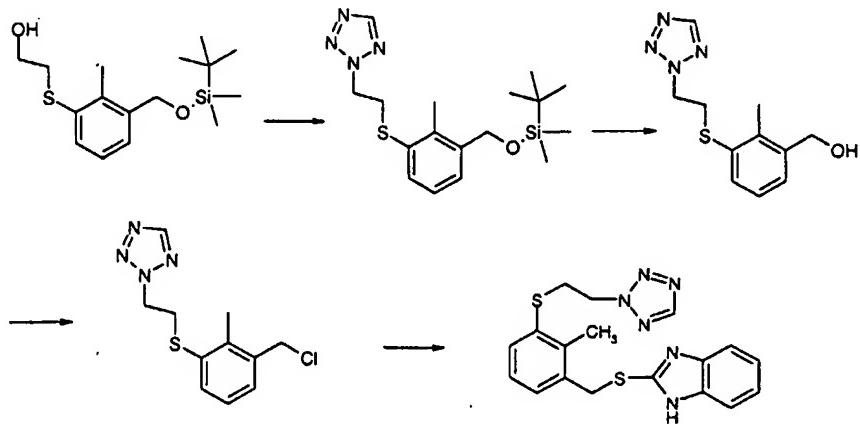


5 *N*-{[2-((3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]carbonyl}phenylalanine

25 mg of ethyl 2-((2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy)carbonyl)amino)-3-phenylpropanoate was combined with 0.1 mL 1M KOH, and 0.5 mL dioxane to give a clear solution. After stirring for 1hr at rt the reaction was

10 diluted with water, extracted twice with ethyl acetate, the aq layer was acidified with conc HCl and extracted three times with ethyl acetate. The organic layer was dried over MgSO<sub>4</sub> and evaporated to yield a clear oil. Trituration with 1:1 ether/hexane gave *N*-{[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]carbonyl}phenylalanine as a white solid: 20 mg. Mass spec.; M+H=522.

15 **Scheme 11**



2-(2-((3-((*tert*-Butyl(dimethyl)silyloxy)methyl)-2-methylphenyl)sulfanyl)ethyl)-2*H*-1,2,3,4-tetraazole

2-{[3-({[tert-Butyl(dimethyl)silyl]oxy}methyl)-2-methylphenyl]sulfanyl}-1-ethanol, 1.2 g, triphenylphosphine, 1.6 g, and tetrazole, 0.42 g, were combined in 10 mL THF to give a clear solution. The mixture was cooled to 0 °C, and 0.94 mL diethylazodicarboxylate was added. The reaction was allowed to slowly come to rt while stirring overnight. Evaporation and purification by flash chromatography, silica gel, 9:1 hexane : ethyl acetate, gave 2-(2-{[3-({[tert-butyl(dimethyl)silyl]oxy}methyl)-2-methylphenyl]sulfanyl}ethyl)-2*H*-1,2,3,4-tetraazole as an oil, 770 mg.

**(2-Methyl-3-([2-(2*H*-1,2,3,4-tetraazol-2-yl)ethyl]sulfanyl)phenyl)methanol**

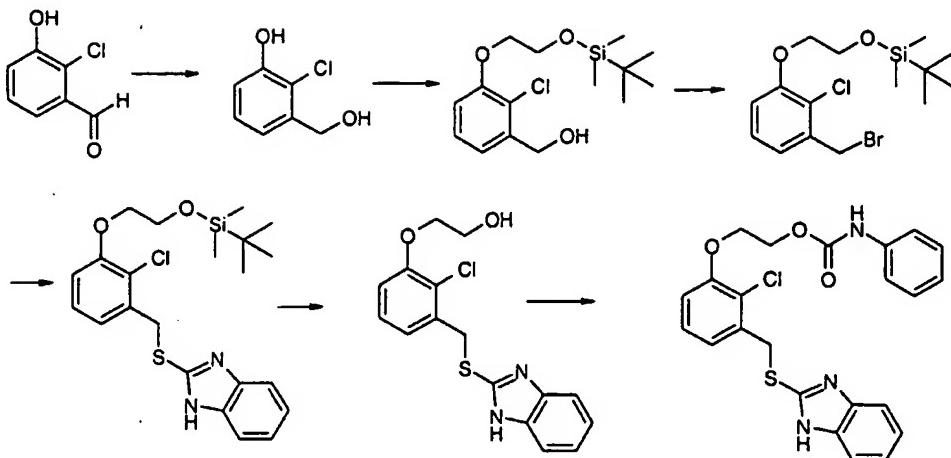
2-(2-{[3-({[tert-Butyl(dimethyl)silyl]oxy}methyl)-2-methylphenyl]sulfanyl}ethyl)-2*H*-1,2,3,4-tetraazole, 770 mg, was dissolved in 20 mL THF and treated with 3 mL 75% aq. TBAF (tetrabutylammonium fluoride). The solution was stirred at rt overnight, concentrated, diluted with ethyl acetate, washed with 10% citric acid, then brine and dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation and purification by flash chromatography, silica gel, 1:1 hexane : ethyl acetate, gave (2-methyl-3-([2-(2*H*-1,2,3,4-tetraazol-2-yl)ethyl]sulfanyl)phenyl)methanol, 500 mg.

**15 2-(2-({[3-(Chloromethyl)-2-methylphenyl]sulfanyl}ethyl)-2*H*-1,2,3,4-tetraazole**

To a solution of 100 mg of (2-methyl-3-([2-(2*H*-1,2,3,4-tetraazol-2-yl)ethyl]sulfanyl)phenyl)methanol in 4 mL methylene chloride at 0 °C was added 1 mL thionyl chloride. The cold bath was removed and the mixture was stirred at rt for 1.5 hrs. Evaporation to dryness gave 2-(2-{[3-(chloromethyl)-2-methylphenyl]sulfanyl}ethyl)-2*H*-1,2,3,4-tetraazole, 105 mg.

**1*H*-Benzimidazol-2-yl 2-methyl-3-([2-(2*H*-1,2,3,4-tetraazol-2-yl)ethyl]sulfanyl)benzyl sulfide**

2-(2-{[3-(chloromethyl)-2-methylphenyl]sulfanyl}ethyl)-2*H*-1,2,3,4-tetraazole, 105 mg, was dissolved in 2 mL DMF, 1 g K<sub>2</sub>CO<sub>3</sub> and 100 mg 2-thiobenzimidazole were added and the suspension was stirred at rt overnight. The mixture was diluted with water, extracted with methylene chloride, washed with brine, dried over MgSO<sub>4</sub>, and evaporated. Purification by flash chromatography, silica gel, 1.5 : 1 ethyl acetate : hexane gave 1*H*-benzimidazol-2-yl 2-methyl-3-([2-(2*H*-1,2,3,4-tetraazol-2-yl)ethyl]sulfanyl)benzyl sulfide as an off-white solid, 70 mg. Mass spec.; M+H=383.

**Scheme 12****2-Chloro-3-(hydroxymethyl)phenol**

2 g 2-chloro-3-hydroxybenzaldehyde (Ginsburg, D. *J.Amer.Chem.Soc.* 1951(73), 702)

- 5 was dissolved in 30 mL THF / 10 mL methanol / 20 mL 1N KOH. 1 g NaBH<sub>4</sub> was added. After stirring at RT for 1.5 hrs, the mixture was diluted with water and extracted with ether (2X). The aqueous layer was acidified with conc. HCl, and extracted with ethyl acetate (2X). The pooled ethyl acetate layer was dried over MgSO<sub>4</sub> and evaporated to give 2-chloro-3-(hydroxymethyl)phenol as a white solid, 2.02 g.

**10 [3-(2-{{[tert-Butyl(dimethyl)silyl]oxy}ethoxy}-2-chlorophenyl)methanol**

- 2-Chloro-3-(hydroxymethyl)phenol, 0.317 g, K<sub>2</sub>CO<sub>3</sub>, 0.264 g, and (2-bromoethoxy)(*tert*-butyl)dimethylsilane, 0.429 mL, were combined in 10 mL acetonitrile. The suspension was refluxed for 18 hrs, and an additional 0.2 mL (2-bromoethoxy)(*tert*-butyl)dimethylsilane was added. After refluxing the mixture an additional 24 hrs, it was 15 filtered, and evaporated to give a crude residue. Purification by column chromatography (8:2 hexane : ethyl acetate) gave [3-(2-{{[tert-butyl(dimethyl)silyl]oxy}ethoxy}-2-chlorophenyl)methanol as a clear oil, 0.42 g.

**{2-[3-(Bromomethyl)-2-chlorophenoxy]ethoxy}(*tert*-butyl)dimethylsilane**

- N*-bromosuccinimide, 0.47 g, was dissolved in 20 mL methylene chloride and cooled 20 to 0 °C. Dimethylsulfide, 0.213 mL, was added slowly and the mixture was stirred for 30 minutes at 0 °C. A solution of 0.42 g [3-(2-{{[tert-butyl(dimethyl)silyl]oxy}ethoxy}-2-chlorophenyl)methanol in 5 mL methylene chloride was added, and the reaction was allowed to proceed at RT for 2 h. The mixture was concentrated to give crude {2-[3-(bromomethyl)-2-

chlorophenoxy]ethoxy}{*tert*-butyl}dimethylsilane, 0.56 g, used in the next step without any further purification.

**2-[{3-(2-{[*tert*-Butyl(dimethyl)silyl]oxy}ethoxy)-2-chlorobenzyl}sulfanyl]-1*H*-benzimidazole**

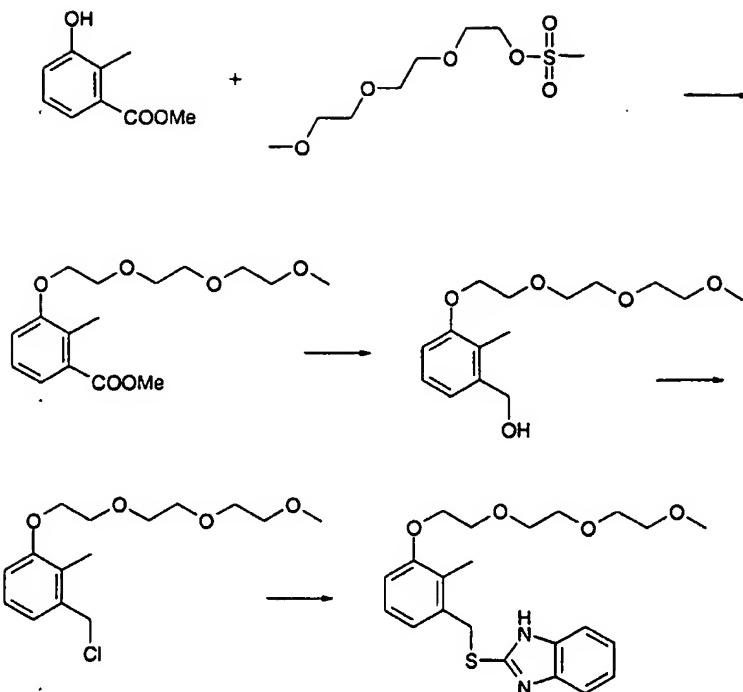
- 5        0.5 g {2-[3-(bromomethyl)-2-chlorophenoxy]ethoxy}{*tert*-butyl}dimethylsilane was combined with 0.2 g benzimidazole and 4 mL 1 M NaOH in 12 mL ethanol. The solution was stirred for 2.5 hrs, and the ethanol was evaporated to yield a slurry. Dilution with ethyl acetate, extraction with water, then sat. NaCl gave a clear solution. The solution was dried over MgSO<sub>4</sub>, and evaporated to give 2-[{3-(2-{[*tert*-butyl(dimethyl)silyl]oxy}ethoxy)-2-chlorobenzyl}sulfanyl]-1*H*-benzimidazole as a white foam, 0.53 g.

**2-[3-[(1*H*-Benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy]-1-ethanol**

- 10      0.53 g 2-[{3-(2-{[*tert*-butyl(dimethyl)silyl]oxy}ethoxy)-2-chlorobenzyl}sulfanyl]-1*H*-benzimidazole was dissolved in 10 mL THF and 0.52 mL 2.73 M aqueous tetrabutylammonium fluoride was added. The solution was stirred for 2 hrs, diluted with water, and extracted with ethyl acetate. The organic phase was washed with sat. NaCl, dried over MgSO<sub>4</sub> and evaporated to yield 2-[3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy]-1-ethanol as 0.4 g white foamy oil.

**2-[3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}ethyl phenylcarbamate**

- 15      0.4 g 2-[3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy]-1-ethanol was dissolved in 5 mL chloroform and 0.15 mL phenyl isocyanate was added. The mixture was stirred at RT for 2 hrs, diluted with chloroform, washed with water, and sat. NaCl. The solution was dried over MgSO<sub>4</sub> and evaporated to yield 2-[3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}ethyl phenylcarbamate as 0.52g white solid.
- Compounds 119 and 120 can be made by a similar route, but using 2-methoxy-
- 20      25 3-(hydroxymethyl)phenol (see Chemistry Letters, 1986,871) in place of 2-chloro-3-(hydroxymethyl)phenol.

**Scheme 13****Methyl 2-methyl-3-[2-(2-methoxyethoxy)ethoxy]benzoate**

Methyl 2-methyl-3-hydroxybenzoate [Fringuelli, F.; Mancini, V.; Taticchi, A.

- 5    *Tetrahedron*, 1969, 25, 4249] (0.5 g) was dissolved in 10 mL MeCN, anhydrous K<sub>2</sub>CO<sub>3</sub> (1 g) was added followed by 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate [prepared by reaction of the corresponding alcohol with methanesulfonyl chloride] (1.09 g). The mixture was allowed to react at reflux over night, cooled, filtered, and taken to dryness. The residue was dissolved in CH<sub>2</sub>Cl<sub>2</sub> and washed with diluted NaOH (aq) and brine. The organic layer
- 10    was collected, dried, and evaporated furnishing 0.56g of the title compound which was used without further purification.

**2-Methyl-3-[2-(2-methoxyethoxy)ethoxy]benzyl alcohol**

A solution of Methyl 2-methyl-3-[2-(2-methoxyethoxy)ethoxy]benzoate

- (2.1 mmol) in THF (10 mL) was gently added to a stirred suspension of LiAlH<sub>4</sub> (4.5 mmol) in
- 15    20 mL THF, then heated to reflux for 2 hours. The reaction was quenched with 0.25 mL water, 0.5 mL 2M NaOH, and 0.25 mL water. The mixture was refluxed for another hour and then filtered to remove the solids. The filtrate was evaporated affording 0.28 g of the title compound.

**2-Methyl-3-[2-(2-methoxyethoxy)ethoxy]benzyl chloride**

2-Methyl-3-[2-(2-methoxyethoxy)ethoxy]benzyl alcohol (1.1 mmol) was dissolved 5 mL CH<sub>2</sub>Cl<sub>2</sub> and treated with 0.2 mL SOCl<sub>2</sub> for 30 min at ambient temperature.

The solvent and excess reagent were evaporated leaving a quantitative yield of the title

5 compound which was used immediately in the next step.

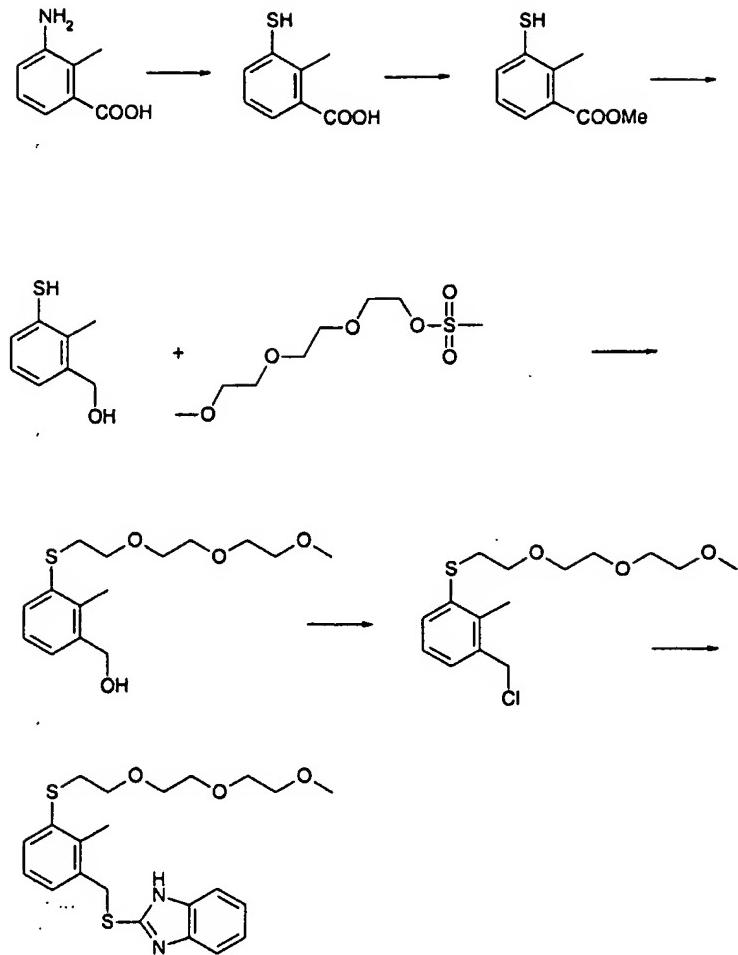
**2-[(3-{2-[2-(2-Methoxyethoxy)ethoxy]ethoxy}-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole**

2-mercaptopbenzimidazole (0.18 g, 1.18 mmol), suspended in 3 mL MeOH, was treated with 2 M NaOH (1.3 mL, 2.6 mmol) and allowed to form a solution. 2-Methyl-3-[2-(2-

10 methoxyethoxy)ethoxy]benzyl chloride (0.33 g, 1.08 mmol) was added and reacted for 18 h at ambient temperature. The solvents were evaporated and the residue partitioned between water and CH<sub>2</sub>Cl<sub>2</sub> (4 x 25 mL). The organic layers were combined, dried, and evaporated. Reverse phase preparative LC afforded 115 mg (26%) of the title compound.

Compound 107 can be prepared by a similar scheme by replacing 2-[2-(2-

15 methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate.

**Scheme 14****2-Methyl-3-mercaptop-benzoic acid**

3-Amino-2-methylbenzoic acid, 11.3 g, was dissolved in H<sub>2</sub>O (100 mL) and conc.

- 5 HCl (15 mL) was added at 0 °C. NaNO<sub>2</sub> (5.5g) in H<sub>2</sub>O (40 mL) was added to the above suspension over 30min. The above diazonium salt was kept at 0 °C and added slowly (over 40 min) to a solution of potassium ethylxanthogenate (14 g) while the pH continually was adjusted to 8 with Na<sub>2</sub>CO<sub>3</sub>. The mixture was stirred for 30 minutes, cooled to ambient temperature, and poured onto a mixture of 300 mL concentrated HCl and 700 mL of ice water.
- 10 The precipitate was collected, taken up in water (300 mL), and treated with NaOH (6 g) at reflux for 20 h. The mixture was poured onto a mixture of 40 mL concentrated HCl in 300 mL ice water and extracted with 3 × 500 mL CH<sub>2</sub>Cl<sub>2</sub>. The combined organic layers were dried and evaporated furnishing 7 g of the title compound as yellow crystals (which slowly oxidized to the corresponding disulfide upon standing)

**2-Methyl-3-mercaptop-methylbenzoate**

2-Methyl-3-mercaptop-benzoic acid (14.7 g) was dissolved in 250 mL of MeOH and a few drops of conc. H<sub>2</sub>SO<sub>4</sub> was added. The mixture was heated to reflux for 48 hours and then allowed to cool to ambient temperature before the bulk MeOH was evaporated. The residue 5 was dissolved in Et<sub>2</sub>O and washed with 4 x 50 mL H<sub>2</sub>O and 50 mL brine. The organic layer was collected, dried, and evaporated leaving 14.8 g of the title compound as a viscous yellow oil (which slowly oxidized to the corresponding disulfide upon standing).

**2-Methyl-3-mercaptop-benzylalcohol**

A solution of 2-Methyl-3-mercaptop-methylbenzoate (2.0 g) in THF (5 mL) was added 10 drop wise to a suspension of LiAlH<sub>4</sub> (1.32 g) in THF (100 mL) under dry and inert conditions. The mixture was heated to reflux for 2 h and then quenched with 2 mL of water, 4 mL of 2 M NaOH, and another 2 mL of water. After refluxing for another hour, solids were filtered off and washed with THF and methanol. The combined filtrates were evaporated and the residue partitioned between 2M HCl and EtOAc. The organic layer was collected, dried, 15 and evaporated to yield 1.9 g 2-Methyl-3-mercaptop-benzylalcohol, contaminated with the corresponding disulfide as an oil. This material could be used in the next step without further purification.

**2-Methyl-3-(2-(2-methoxyethoxy)ethoxy)ethylthio)benzyl alcohol**

A mixture of 2-Methyl-3-mercaptop-benzylalcohol and its disulfide (50 mg, 0.325 20 mmol monomer) in dioxane/water (4/1) (1 mL) and a small amount of concentrated HCl was reacted with PPh<sub>3</sub> (26 mg, 0.1 mmol) for 1 h at ambient temperature in an inert atmosphere. The solvents were removed and the residue taken up in MeCN (1 mL) and reacted with Et<sub>3</sub>N (290 mL, 2.08 mmol) and 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate [prepared by reaction of the corresponding alcohol with methanesulfonyl chloride] (0.30 g, 1.24 mmol) 25 for 3 days at ambient temperature. The solvent was evaporated and the residue partitioned between EtOAc and water. The organic layer was collected, dried, and taken to dryness. The product was purified on silica gel (pentane/Et<sub>2</sub>O; 6/4 to 0/10) furnishing 50 mg of the title compound as a colorless oil.

**2-Methyl-3-[2-(2-methoxyethoxy)ethoxy)ethylthio]benzyl chloride**

30 2-Methyl-3-(2-(2-methoxyethoxy)ethoxy)ethylthio)benzyl alcohol (0.17 mmol) was dissolved in 2 mL CH<sub>2</sub>Cl<sub>2</sub> and treated with 0.1 mL SOCl<sub>2</sub> for 30 min at ambient temperature. The solvent and excess reagent were evaporated leaving a quantitative yield of the title compound which was used immediately in the next step.

**2-{[3-({2-[2-(2-Methoxyethoxy)ethoxy]ethyl}sulfanyl)-2-methylbenzyl]sulfanyl}-1*H*-benzimidazole**

2-Mercaptobenzimidazole (0.33 g, 2.16 mmol), suspended in 6 mL MeOH, was treated with 2 M NaOH (2.6 mL) and allowed to form a solution. 2-Methyl-3-[2-(2-methoxyethoxy)ethoxy]ethylthio]benzyl chloride (0.58 g, 1.80 mmol) was added and reacted for 18 h at ambient temperature. The solvents were evaporated and the residue partitioned between water and CH<sub>2</sub>Cl<sub>2</sub> (4 x 25 mL). The organic layers were combined, dried, and evaporated. Reverse phase preparative LC afforded 0.47 g of the title compound.

Compound 109 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate.

Compound 112 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with isobutyl bromide.

Compound 115 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate, and 2-mercaptobenzimidazole replaced with 5-carboethoxy-2-mercaptobenzimidazole.

Compound 116 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate, and 2-mercaptobenzimidazole replaced with 5-(propan-1-one)-2-mercaptobenzimidazole.

Compound 117 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate, and 2-mercaptobenzimidazole replaced with 5-amino-2-mercaptobenzimidazole.

Compound 118 can be prepared by a similar scheme by replacing 2-[2-(2-methoxyethoxy)ethoxy]ethyl methanesulfonate with 3,6,9,12,15-pentaoxahexadec-1-yl methanesulfonate, and 2-mercaptobenzimidazole replaced with 5-(hydroxymethyl)-2-mercaptobenzimidazole.

Table 1 shows which compounds can be made by each of Schemes 1 to 14 or by schemes that are similar to schemes 1 to 14, but differ in one or more reagents as will be readily apparent to the skilled person taking into account the final compound.

**Table 1**

<u>SCHEME</u>	<u>COMPOUND NO.</u>
1	1-37
2	38-54
3	55-82
4	83, 84, 113, 114
5	104
6	103, 105, 110, 111
7	85-96
8	97, 98
9	99
10	100
11	101, 102
12	119-122
13	106, 107
14	108, 109, 112, 115-118

**ASSAYS*****Microdilution assay***

5        The microdilution assay tests the anti-*H. pylori* activity of compounds. In this assay, MICs (Minimum Inhibitory Concentrations) were determined against four *H. pylori* strains, including ATCC 43504, that exhibit different susceptibilities to known antibiotics. The tests were performed in 24-well microtiter plates in which the medium, the inoculum, and the antibiotic solutions were distributed in the wells. Serial dilutions were prepared in 24-well

10      plates containing a total volume of 2 mL medium per well. Cultures were resuspended in Brucella broth (OD<sub>600</sub> of 0.6) and 50 µl of these cultures were inoculated into each well to give a final concentration of 10<sup>7</sup> cells per mL (OD<sub>600</sub> of less than 0.03, which is the same as that of the non-inoculated control). The plates were then incubated for two days and the amount of growth recorded (OD<sub>600</sub>) with a plate reader (Molecular Devices, Sunnyvale, California). The plates were incubated in a controlled microaerophilic atmosphere (5% O<sub>2</sub>, 10% CO<sub>2</sub> and 85% N<sub>2</sub>) that assured optimal growth of the bacterial strains and high

reproducibility of results. The MIC was defined as the lowest concentration of antibiotic resulting in complete inhibition of growth.

MIC values <10 $\mu$ g/mL are indicative of anti-*Helicobacter pylori* activity. Compounds according to the invention were tested in this assay and give MIC values in this range.

##### 5 Selectivity Assays

Standard agar dilution protocols were used to determine the effect of compounds of the invention on panels of Gram negative and Gram positive bacteria. The effects on both aerobic [“Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically-Fourth Edition; Approved Standard” NCCLS Document M7-A4 Vol. 17 No. 2,

- 10 January 1997] and anaerobic [“Methods for Antimicrobial Susceptibility Testing of anaerobic Bacteria -Third Edition; Approved Standard” NCCLS Document M11-A3 Vol. 13 No. 26, December 1993] organisms were measured. Compounds of the invention had no effect in these assays at concentrations of greater than ten times the corresponding MICs determined vs. *Helicobacter pylori* in the microdilution assay.

- 15 The invention relates in one aspect to a compound of formula I for use as a medicament. The compound can be provided as part of a pharmaceutical formulation which also includes a pharmaceutically acceptable diluent or carrier (e.g., water). The formulation may be in the form of tablets, capsules, granules, powders, syrups, emulsions (e.g., lipid emulsions), suppositories, ointments, creams, drops, suspensions (e.g., aqueous or oily suspensions) or solutions (e.g., aqueous or oily solutions). If desired, the formulation may include one or more additional substances independently selected from stabilising agents, wetting agents, emulsifying agents, buffers, lactose, sialic acid, magnesium stearate, terra alba, sucrose, corn starch, talc, gelatin, agar, pectin, peanut oil, olive oil, cacao butter and ethylene glycol. The formulation may contain or be co-administered with one or more known drugs
- 20 selected from other clinically useful antibacterial agents.

- 25 The compound is preferably orally administered to a patient, but other routes of administration are possible, such as parenteral or rectal administration. For intravenous, subcutaneous or intra-muscular administration, the patient may receive a daily dose of 5 mgkg<sup>-1</sup> to 20 mgkg<sup>-1</sup> of the compound, the compound being administered 1 to 4 times per day. The intravenous, subcutaneous and intra-muscular dose may be given by means of a bolus injection. Alternatively, the intravenous dose may be given by continuous infusion over a period of time. Alternatively, the patient may receive a daily oral dose which is

approximately equivalent to the daily parenteral dose, the composition being administered 1 to 4 times per day. A suitable pharmaceutical formulation is one suitable for oral administration in unit dosage form, for example as a tablet or capsule, which contains between 100mg and 1g of the compound of the invention.

5 The following illustrate representative pharmaceutical dosage forms containing the compound of the invention, or a pharmaceutically acceptable salt or solvate thereof (hereafter referred to as "compound X"), for therapeutic or prophylactic use in humans.

(a)

<u>Tablet I</u>	<u>mg/tablet</u>
Compound X.	100
Lactose Ph.Eur.	179
Croscarmellose sodium	12.0
Polyvinylpyrrolidone	6
Magnesium stearate	3.0

10 (b)

<u>Tablet II</u>	<u>mg/tablet</u>
Compound X	50
Lactose Ph.Eur.	229
Croscarmellose sodium	12.0
Polyvinylpyrrolidone	6
Magnesium stearate	3.0

(c)

<u>Tablet III</u>	<u>mg/tablet</u>
Compound X	1.0
Lactose Ph.Eur.	92
Croscarmellose sodium	4.0
Polyvinylpyrrolidone	2.0
Magnesium stearate	1.0

(d)

<u>Capsule</u>	<u>mg/capsule</u>
Compound X	10
Lactose Ph.Eur.	389
Croscarmellose sodium	100
Magnesium stearate	1.

(e)

<u>Injection I</u>	<u>(50 mg/mL)</u>
Compound X	5.0% w/v
Isotonic aqueous solution	to 100%

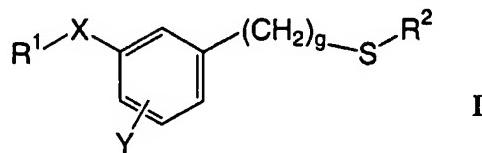
5        Buffers, pharmaceutically acceptable co-solvents (e.g., polyethylene glycol, propylene glycol, glycerol or EtOH) or complexing agents such as hydroxy-propyl  $\beta$  cyclodextrin may be used to aid formulation.

Another aspect of the invention relates to the use of a compound of formula I, in the manufacture of a medicament, for the therapeutic and/or prophylactic treatment of  
10      *Helicobacter pylori* infection in a mammalian host, e.g. a human. By "therapeutic treatment", we mean the eradication or suppression of a pre-existing *Helicobacter pylori* infection in the host.

In a further aspect of the invention, there is provided a method of therapeutically treating or preventing *Helicobacter pylori* infection in a mammal (e.g., a human), the method  
15      comprising administering (e.g., orally) to the mammal a compound of formula I or a pharmaceutical formulation as described above. By "therapeutically treating", we mean bringing about the eradication or suppression of a pre-existing *Helicobacter pylori* infection in the host.

**CLAIMS:**

1. A compound of formula I or a pharmaceutically acceptable salt or solvate thereof



5 wherein:

X is S; SO<sub>2</sub>; NH; N(C<sub>1-6</sub>alkyl); O or CH<sub>2</sub>;

Y is C<sub>1-6</sub>alkyl; O(C<sub>3-8</sub>cycloalkyl); O(C<sub>1-6</sub>alkyl); Hal; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal, OCHal<sub>3</sub>,

OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal, wherein Hal represents halogen; NRR', wherein R and R'

independently represent H or C<sub>1-8</sub>alkyl, or NRR' represents an optionally substituted

- 10 C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S; H; COOR'' or COR'', R'' representing H or C<sub>1-6</sub>alkyl; or CH<sub>2</sub>OH;

R<sup>1</sup> is -(CH<sub>2</sub>)<sub>a</sub>-R<sup>3</sup>; -((CH<sub>2</sub>)<sub>b</sub>O)<sub>c</sub>-R<sup>3</sup>; -(CH<sub>2</sub>)<sub>d</sub>-R<sup>3</sup>; -(CH<sub>2</sub>)<sub>a</sub>C(=O)R<sup>3</sup>; -(CH<sub>2</sub>)<sub>d</sub>C(=O)R<sup>3</sup>;

-((CH<sub>2</sub>)<sub>e</sub>-O)<sub>c</sub>-(CH<sub>2</sub>)<sub>f</sub>-R<sup>3</sup>; R<sup>3</sup> or R<sup>3</sup>;

R<sup>2</sup> is an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered

- 15 heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S;

R<sup>3</sup> is H; C<sub>1-6</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure

- 20 containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S;

R<sup>3</sup>' is -Z-M wherein Z represents O, S or NH and M represents H, an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, or an optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms

- 25 independently selected from O, N and S; or -Z-M represents -C(=O)NR<sup>6</sup>R<sup>7</sup>, -NR<sup>6</sup>R<sup>7</sup>, -OC(=O)NR<sup>8</sup>R<sup>9</sup>, -NC(=O)NR<sup>8</sup>R<sup>9</sup> or -NC(=O)R<sup>8</sup>;

For R<sup>6</sup> and R<sup>7</sup>, either:

(i) R<sup>6</sup> is H; C<sub>1-12</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; optionally substituted (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub>; optionally substituted

- 30 (C<sub>1-8</sub>alkyl)R, where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered

heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S or R represents a mono-, bi- or tri-cyclic C<sub>3-13</sub>cycloalkyl; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; or -C(=O)-

5 O-Ar, wherein Ar represents optionally substituted C<sub>6-10</sub>aryl; and

R<sup>7</sup> is H; or

(ii) the structure -NR<sup>6</sup>R<sup>7</sup> represents a C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S, -NR<sup>6</sup>R<sup>7</sup> being optionally substituted;

10 a represents an integer 1, 2, 3, 4 or 5;

each b independently represents an integer 1, 2, 3, 4 or 5;

c represents an integer 1, 2, 3, 4 or 5;

c' represents an integer 1, 2, 3, 4 or 5;

d represents an integer 1, 2, 3, 4 or 5;

15 each e independently represents an integer 1, 2, 3, 4 or 5;

f represents an integer 1, 2, 3, 4 or 5; and

g represents zero or an integer 1, 2, 3, 4 or 5;

or a pharmaceutically acceptable salt or solvate thereof.

20 2. A compound according to Claim 1, wherein:

a is 1, 2 or 3;

b is 2;

c' is 1, 2, 3, 4 or 5;

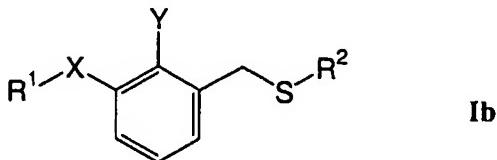
d is 1, 2 or 3;

25 e is 2;

f is 1, 2 or 3; and

g is 1 or 2.

3. A compound according to Claim 2, having the general structure Ib



wherein:

X is S, S(=O), S(=O)<sub>2</sub> or O;

Y is C<sub>1-6</sub>alkyl, O(C<sub>1-6</sub>alkyl), Hal; CHal<sub>3</sub>, CHHal<sub>2</sub>, CH<sub>2</sub>Hal, OCHal<sub>3</sub>, OCHHal<sub>2</sub> or OCH<sub>2</sub>Hal;

5 R<sup>1</sup> is -(CH<sub>2</sub>)<sub>a</sub>-R<sup>3</sup>, -((CH<sub>2</sub>)<sub>2</sub>O)<sub>c</sub>-R<sup>3</sup>, -(CH<sub>2</sub>)<sub>d</sub>-R<sup>3</sup>, -(CH<sub>2</sub>)<sub>a</sub>C(=O)R<sup>3</sup>, -(CH<sub>2</sub>)<sub>d</sub>C(=O)R<sup>3</sup>, -((CH<sub>2</sub>)<sub>2</sub>O)<sub>c</sub>-(CH<sub>2</sub>)<sub>f</sub>-R<sup>3</sup>;

R<sup>3</sup> is C<sub>1-6</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted C<sub>5-10</sub>aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S;

10 or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle;

15 R<sup>3</sup> is -Z-M wherein Z represents O, S or NH and M represents H, an optionally substituted mono- or bi- cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or an optionally substituted C<sub>5-10</sub> aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or -Z-M represents 20 -C(=O)NR<sup>6</sup>R<sup>7</sup>, -NR<sup>6</sup>R<sup>7</sup>, -OC(=O)NR<sup>8</sup>R<sup>9</sup>, -NC(=O)NR<sup>8</sup>R<sup>9</sup> or -NC(=O)R<sup>8</sup>;

For R<sup>6</sup> and R<sup>7</sup>, either:

(i) R<sup>6</sup> is H; C<sub>1-12</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; optionally substituted (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub>; optionally substituted (C<sub>1-8</sub>alkyl)R, where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered 25 heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or R represents a mono-, bi- or tri-cyclic C<sub>3-13</sub>cycloalkyl; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected 30 from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle; or -C(=O)-O-Ar, wherein Ar represents optionally substituted C<sub>6-10</sub>aryl; and

- 84 -

$R^7$  is H; or

- (ii) the structure  $-NR^6R^7$  represents a  $C_{3-8}$  heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S per cycle;  $-NR^6R^7$  being optionally substituted;
- 5 or a pharmaceutically acceptable salt or solvate thereof.

4. A compound according to Claim 3, wherein:

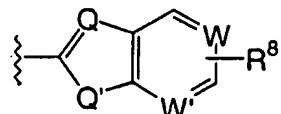
$X$  is S or O;

- 10  $R^1$  is  $-(CH_2)_2R^3$ ,  $-(CH_2)_2R^3$ ,  $-CH_2C(=O)R^3$  or  $-CH_2C(=O)R^3$ ; and  
 $R^3$  is optionally substituted  $C_{3-8}$ cycloalkyl optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; optionally substituted  $C_{5-10}$ aromatic ring structure optionally containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or an optionally substituted 5- to 10-membered mono- or bi-cyclic heterocyclic ring structure 15 containing 1, 2, 3, 4 or 5 heteroatoms independently selected from O, N and S.

5. A compound according to either Claim 1, 2 or 3, wherein  $R^1$  is selected from *iso*-Bu,  $-(CH_2CH_2O)_3CH_3$ ,  $-(CH_2CH_2)-4$ -morpholinyl,  $-(CH_2CH_2O)_5CH_3$ ,  $-(CH_2CH_2)-1-(2$ -methyl-5-nitro-imidazolyl),  $-(CH_2CH_2)-1-(1,2,4$ -triazolyl), and  $-(CH_2CH_2)-OC(=O)NH-Ph$ .

20

6. A compound according to any one of Claims 1, 2 or 3, wherein  $R^2$  represents



wherein:

$Q$  is CH or N;

25  $Q'$  is NH, O or S;

$W$  is CH or N;

$W'$  is CH or N; and

$R^8$  is  $C_{1-6}$ alkyl;  $O(C_{3-8}$ cycloalkyl);  $O(C_{1-6}$ alkyl); Hal;  $CHal_3$ ,  $CHHal_2$ ,  $CH_2Hal$ ,

$OCHal_3$ ,  $OCHHal_2$  or  $OCH_2Hal$ , wherein Hal represents halogen;  $NRR'$ , wherein  $R$  and  $R'$

- 30 independently represent H or  $C_{1-8}$ alkyl, or  $NRR'$  represents an optionally substituted  $C_{3-8}$ heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently

selected from O, N and S, wherein the heterocyclic ring contains at least one carbon atom and contains no more than one O and no more than one S; H; COOR<sup>9</sup> or COR<sup>9</sup>, R<sup>9</sup> representing H or C<sub>1-6</sub>alkyl; or CH<sub>2</sub>OH.

5 7. A compound of Claim 1, wherein R<sup>1</sup> is -(CH<sub>2</sub>)<sub>a</sub>-CH<sub>3</sub> or -((CH<sub>2</sub>)<sub>b</sub>O)<sub>c</sub>-CH<sub>3</sub>.

8. A compound according to Claim 2, wherein R<sup>3'</sup> is selected from -4-morpholinyl, -1-(2-methyl-5-nitro-imidazolyl), -1-(1,2,4-triazolyl) and -OC(=O)NH-Ph.

10 9. A compound according to any one of Claims 1 through 8, wherein g is 1.

10. A compound of Claim 1, wherein the compound is selected from:

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-ethanol;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl

15 isopropylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-phenoxyphenylcarbamate;

20 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl pentylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2,5-dimethylphenylcarbamate;

25 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl (1*S*,2*R*)-2-phenylcyclopropylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl cyclohexylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-(methylsulfanyl)phenylcarbamate;

30 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenethylcarbamate;

2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2-(2-thienyl)ethylcarbamate;

- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl  
methylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2-  
methylphenylcarbamate;
- 5 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-  
methoxyphenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-  
fluorophenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl  
10 benzylcarbamate;
- methyl 3-((2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-  
methylphenyl)sulfanyl)ethoxy)carbonyl)amino)benzoate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,4-  
dichlorobenzylcarbamate;
- 15 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,4-  
difluorophenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenyl  
dicarbonimidoate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-  
20 bromophenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-  
methylbenzylcarbamate;
- ethyl 2-((2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-  
methylphenyl)sulfanyl)ethoxy)carbonyl)amino)-3-phenylpropanoate;
- 25 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,5-dimethyl-4-  
isoxazolylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3-  
acetylphenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl  
30 benzoylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-chloro-2-  
methylphenylcarbamate;

- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-methoxybenzylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,4-dichlorophenylcarbamate;
- 5 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-(dimethylamino)phenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2,5-dichlorophenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 3,5-dimethoxyphenylcarbamate;
- 10 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2,4-dimethoxyphenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl (1*R*)-1-phenylethylcarbamate;
- 15 ethyl 4-(([2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]carbonyl)amino)benzoate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 2-ethylphenylcarbamate;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl 4-fluorobenzoylcarbamate;
- 20 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethylamine;
- N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]benzamide;
- N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]cyclohexanecarboxamide;
- 25 *N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-[(4*S*)-2,5-dioxoimidazolidinyl]acetamide;
- tert*-butyl 4-(([2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]amino)carbonyl)-1-piperidinecarboxylate;
- N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-2-
- 30 pyrazinecarboxamide;
- 2-(1-adamantyl)-*N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]acetamide;

- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-2-(1,3-dimethyl-2,6-dioxo-1,2,3,6-tetrahydro-7*H*-purin-7-yl)acetamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-2-furamide;*
- 5 *N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-5-nitro-2-furamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-2-thiophenecarboxamide;*
- 10 *N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-1-benzofuran-2-carboxamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-1-ethyl-3-methyl-1*H*-pyrazole-5-carboxamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]nicotinamide;*
- 15 *N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-4-quinolinicarboxamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-3,5-dimethyl-4-isoxazolecarboxamide;*
- N*-[2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)ethyl]-5-20 isoxazolecarboxamide;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)acetamide;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-*N*-cyclopropylacetamide;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-*N*-(1,3-benzodioxol-25 5-ylmethyl)acetamide;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-1-(1-piperidinyl)-1-ethanone;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-*N*-(2-furylmethyl)acetamide;*
- 30 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-*N*-cyclohexylacetamide;*
- 2-(*{3-[({1H-benzimidazol-2-ylsulfanyl)methyl]}-2-methylphenyl}sulfanyl)-*N*-(tetrahydro-2-furanylmethyl)acetamide;*

- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-cyclopentylacetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2-thienylmethyl)acetamide;
- 5 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-[2-(4-morpholinyl)ethyl]acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2,3-dihydro-1*H*-inden-2-yl)acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-benzylacetamide;
- 10 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(2,5-dimethoxyphenethyl)acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-[2-(2-pyridinyl)ethyl]acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-[2-(1-methyl-2-pyrrolidinyl)ethyl]acetamide;
- 15 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(3,3-diphenylpropyl)acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-phenethylacetamide;
- 20 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(4-methoxyphenethyl)acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-hexylacetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-isobutylacetamide;
- 25 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(4-pyridinylmethyl)acetamide;
- N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)acetyl]-2-furohydrazide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-octahydro-1(2*H*)-
- 30 quinolinyl-1-ethanone;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(benzyloxy)acetamide;

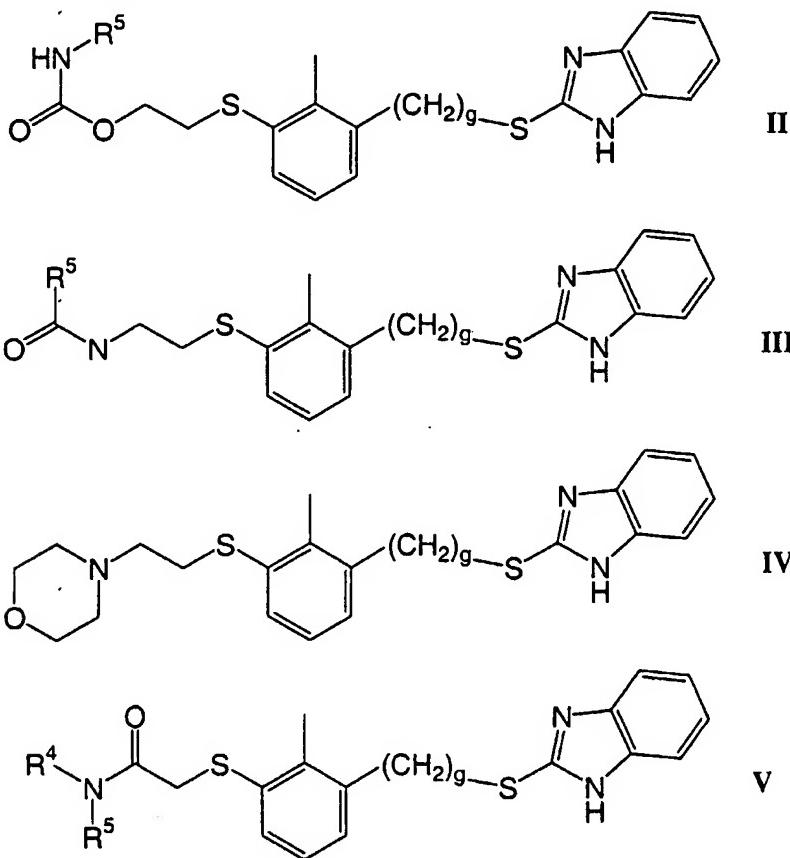
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-[4-(2-methoxyphenyl)-1-piperazinyl]-1-ethanone;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-[6,7-dimethoxy-3,4-dihydro-2(*H*)-isoquinolinyl]-1-ethanone;
- 5 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-*N*-(4-butylphenyl)acetamide;
- 2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)-1-(4-methyl-1-piperazinyl)-1-ethanone;
- 2-[(2-methyl-3-[(2-(4-morpholinyl)ethyl)sulfanyl]benzyl)sulfanyl]-1*H*-benzimidazole;
- 10 2-[(2-methyl-3-[(2-(4-methyl-1-piperazinyl)ethyl)sulfanyl]benzyl)sulfanyl]-1*H*-benzimidazole;
- 2-((3-[(1*H*-imidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate;
- 2-[(2-methyl-3-[(5-phenyl-1,3,4-oxadiazol-2-yl)sulfanyl]methyl)phenyl)sulfanyl]ethyl phenylcarbamate;
- 15 2-((2-methyl-3-[(2-pyrimidinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate;
- 2-[(2-methyl-3-[(1-phenyl-1*H*-1,2,3,4-tetrazol-5-yl)sulfanyl]methyl)phenyl)sulfanyl]ethyl phenylcarbamate;
- 2-[(3-[(4,5-diphenyl-1*H*-imidazol-2-yl)sulfanyl]methyl)-2-methylphenyl)sulfanyl]ethyl phenylcarbamate;
- 20 2-((3-[(3*H*-imidazo[4,5-*c*]pyridin-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate;
- 2-((3-[(1,3-benzoxazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl phenylcarbamate;
- 2-((2-methyl-3-[(2-pyridinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate;
- 2-((2-methyl-3-[(4-pyridinylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate;
- 25 2-[(2-methyl-3-[(4-phenyl-1,3-thiazol-2-yl)sulfanyl]methyl)phenyl)sulfanyl]ethyl phenylcarbamate;
- 2-((2-methyl-3-[(1,3-thiazol-2-ylsulfanyl)methyl]phenyl)sulfanyl)ethyl phenylcarbamate;
- 2-[(3-[(5-methoxy-1*H*-benzimidazol-2-yl)sulfanyl]methyl)-2-methylphenyl)sulfanyl]ethyl phenylcarbamate;
- 30 *N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-*N*'-phenylurea;
- N*-[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethyl]-*N*'-(2-pyrazinyl)urea;

- 6-[2-({3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl}sulfanyl)ethoxy]-3-nitroimidazo[1,2-*b*]pyridazine;
- 2-[(2-methyl-3-{{2-(2*H*-1,2,3,4-tetrazol-2-yl)ethyl}sulfanyl}benzyl)sulfanyl]-1*H*-benzimidazole;
- 5 2-[(2-methyl-3-{{2-(2*H*-1,2,3,4-tetrazol-2-yl)ethyl}sulfanyl}benzyl)sulfanyl]-3*H*-imidazo[4,5-*c*]pyridine;
- 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole;
- 2-({2-methyl-3-[2-(4-morpholinyl)ethoxy]benzyl}sulfanyl)-1*H*-benzimidazole;
- 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1*H*-indole;
- 10 2-[(3-{2-[2-(2-methoxyethoxy)ethoxy]ethoxy}-2-methylbenzyl)sulfanyl]-1*H*-benzimidazole;
- 2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-yloxy)benzyl}sulfanyl}-1*H*-benzimidazole;
- 2-{{3-{{2-[2-(2-methoxyethoxy)ethoxy]ethyl}sulfanyl}-2-methylbenzyl}sulfanyl}-1*H*-benzimidazole;
- 2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazole;
- 15 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1,3-benzothiazole;
- 2-[(3-isobutoxy-2-methylbenzyl)sulfanyl]-1,3-benzoxazole;
- 2-{{isobutylsulfanyl}-2-methylbenzyl}sulfanyl}-1*H*-benzimidazole;
- 2-{{(2-methyl-3-{{2-(2-methyl-5-nitro-1*H*-imidazol-1-yl)ethyl}sulfanyl}benzyl)sulfanyl}-1*H*-benzimidazole;
- 20 2-[(2-methyl-3-{{2-(1*H*-1,2,4-triazol-1-yl)ethyl}sulfanyl}benzyl)sulfanyl]-1*H*-benzimidazole;
- ethyl 2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazole-5-carboxylate;
- 1-(2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazol-5-yl)-1-propanone;
- 25 2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazol-5-amine;
- (2-{{2-methyl-3-(3,6,9,12,15-pentaoxahexadec-1-ylsulfanyl)benzyl}sulfanyl}-1*H*-benzimidazol-5-yl)methanol;
- 30 2-{{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methoxyphenoxy}-1-ethanol};
- 2-{{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methoxyphenoxy}ethyl phenylcarbamate};
- 2-{{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}-1-ethanol}; and

2-{3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-chlorophenoxy}ethyl phenylcarbamate; *N*-{[2-((3-[(1*H*-benzimidazol-2-ylsulfanyl)methyl]-2-methylphenyl)sulfanyl)ethoxy]carbonyl}phenylalanine; or a pharmaceutically acceptable salt or solvate thereof.

5

11. A compound according to Claim 1, wherein the compound is selected from compounds II, III, IV and V



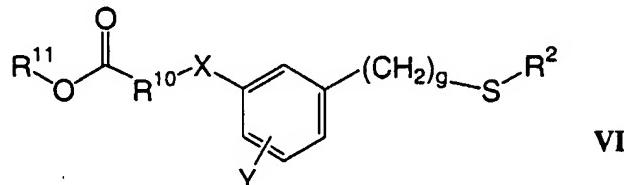
10

wherein,

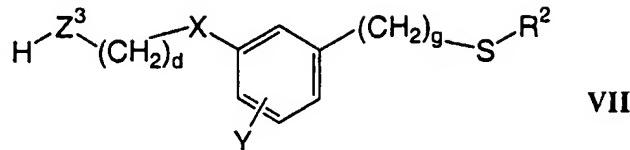
For R<sup>4</sup> and R<sup>5</sup>, either:

- (i) R<sup>4</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl, wherein Z<sup>2</sup> represents O or a bond, and the aryl is C<sub>6-10</sub>, optionally substituted and optionally fused to a C<sub>5-10</sub> heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2 or 3 heteroatoms independently selected from O, N and S; (C<sub>1-8</sub>alkyl)-R, wherein R represents an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring

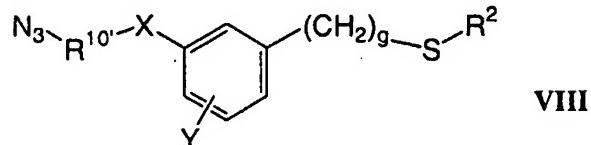
- structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted  $-C(=O)O(C_{1-8}\text{alkyl})$ ; optionally substituted  $-C(=O)O\text{-phenyl}$ ; optionally substituted  $-C(=O)(C_{1-8}\text{alkyl})$ ; optionally substituted  $-C(=O)\text{-phenyl}$ ; or  $-NHC(=O)R^6$ ; and  $R^5$  is H;  $C_{1-8}\text{alkyl}$ ; optionally substituted  $C_{3-8}\text{cycloalkyl}$  optionally fused to a benzene ring;  $(C_{1-8}\text{alkyl})\text{aryl}$  wherein the aryl is  $C_{6-10}$  and optionally substituted; optionally substituted  $C_{6-10}\text{aryl}$ ; or an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or
- (ii) the structure  $-NR^4R^5$  represents a  $C_{3-8}\text{heterocyclic ring}$  optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S and optionally fused to a
- 10  $C_{6-10}$ ring structure,  $-NR^4R^5$  being optionally substituted.
12. A compound according to any one of Claims 1 through 11 for use as a medicament.
13. A pharmaceutical formulation comprising a compound according to any one of Claims 1 through 11 and a pharmaceutically acceptable diluent or carrier.
14. Use of a compound according to any one of Claims 1 through 11, in the manufacture of a medicament, for the therapeutic and/or prophylactic treatment of *Helicobacter pylori* infection in a mammalian host.
- 20 15. A method of therapeutically treating and/or preventing *Helicobacter pylori* infection in a mammal, comprising administering to the mammal a compound according to any one of Claims 1 to 11.
- 25 16. A process for preparing a compound according to Claim 1, wherein the process comprises the steps of:
- (a) reducing compound VI



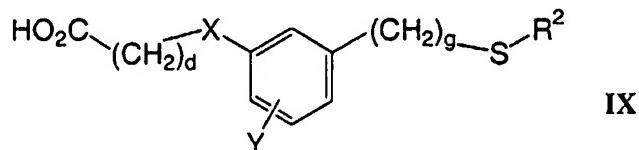
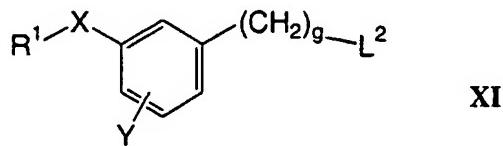
wherein  $R^{10}$  represents  $(CH_2)_d$  or  $-(CH_2)_{f-1}-O-(CH_2)_{e-1}$  and  $R^{11}$  represents H or  $C_{1-6}\text{alkyl}$ ; or

(b) reacting compound VII with R<sup>6</sup>-NCOwherein Z<sup>3</sup> represents O or NH; or

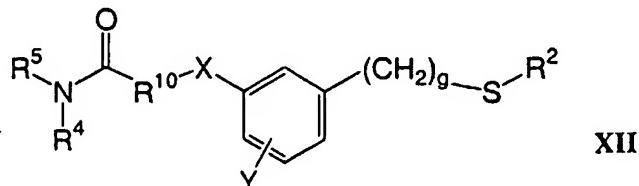
(c) reducing compound VIII



5

wherein R<sup>10'</sup> represents a bond, (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-; or(d) reacting compound VII with R<sup>6</sup>-COOH; or(e) reacting compound IX with NHR<sup>4</sup>R<sup>5</sup>; or10 (f) reacting compound X with NHR<sup>4</sup>R<sup>5</sup>wherein L<sup>1</sup> represents a leaving group and R<sup>10'</sup> represents (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-; or(g) reacting compound XI with R<sup>2</sup>-SH15 wherein L<sup>2</sup> represents a leaving group; or

(h) reducing compound XII



wherein,

For R<sup>4</sup> and R<sup>5</sup>, either:

- (i) R<sup>4</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; Z<sup>2</sup>-(C<sub>1-8</sub>alkyl)aryl, wherein Z<sup>2</sup> represents O or a bond, and the aryl is C<sub>6-10</sub>, optionally substituted and optionally fused to a C<sub>5-10</sub> heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2 or 3 heteroatoms independently selected from O, N and S; (C<sub>1-8</sub>alkyl)-R, wherein R represents an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S;
- 10 optionally substituted -C(=O)O(C<sub>1-8</sub>alkyl); optionally substituted -C(=O)O-phenyl; optionally substituted -C(=O)(C<sub>1-8</sub>alkyl); optionally substituted -C(=O)-phenyl; or -NHC(=O)R<sup>6</sup>; and  
R<sup>5</sup> is H; C<sub>1-8</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub> and optionally substituted; optionally substituted C<sub>6-10</sub>aryl; or an optionally substituted 5-, 6-, 7-, 8-, 9- or 10-membered heterocyclic ring structure containing 1, 2 or 3 heteroatoms independently selected from O, N and S; or
- 15 (ii) the structure -NR<sup>4</sup>R<sup>5</sup> represents a C<sub>3-8</sub>heterocyclic ring optionally containing 1, 2 or 3 further heteroatoms independently selected from O, N and S and optionally fused to a C<sub>6-10</sub>ring structure, -NR<sup>4</sup>R<sup>5</sup> being optionally substituted;  
R<sup>6</sup> is H; C<sub>1-12</sub>alkyl; optionally substituted C<sub>3-8</sub>cycloalkyl optionally fused to a benzo ring; optionally substituted (C<sub>1-8</sub>alkyl)aryl wherein the aryl is C<sub>6-10</sub>; optionally substituted (C<sub>1-8</sub>alkyl)R, where R represents a mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S or R represents a mono-, bi- or tri-cyclic C<sub>3-13</sub>cycloalkyl; optionally substituted C<sub>6-10</sub>aryl; an optionally substituted mono- or bi-cyclic 5-, 6-, 7-, 8-, 9- or 10-membered heterocycle containing 1, 2, 3, 4, 5 or 6 heteroatoms independently selected from O, N and S; or -C(=O)-O-Ar, wherein Ar represents optionally substituted C<sub>6-10</sub>aryl; and
- 20 R<sup>10</sup> is (CH<sub>2</sub>)<sub>d</sub> or -(CH<sub>2</sub>)<sub>f-1</sub>-O-(CH<sub>2</sub>)<sub>e</sub>-.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02192

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: C07D 235/28, A61K 31/4184, A61P 1/04**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: C07D**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0251536 A1 (FISONS PLC), 7 January 1988 (07.01.88) --	1-16
X	EP 0204215 B1 (G.D. SEARLE & CO.), 10 December 1986 (10.12.86) --	1-16
A	US 5576341 A (MITSUO MASAKI ET AL), 19 November 1996 (19.11.96) -- -----	1-16

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search

13 March 2001

Date of mailing of the international search report

14-03-2001

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. + 46 8 666 02 86

Authorized officer

Carolina Gómez Lagerlöf/EÖ  
Telephone No. + 46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE00/02192**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: **15**  
because they relate to subject matter not required to be searched by this Authority, namely:  
**see next sheet**
2.  Claims Nos.: **1-2**  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
**see next sheet**
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE00/02192

**Box I.1**

Claim 15 relates to a method of treatment of the human or animal body by surgery or by therapy/a diagnostic method practised on the human or animal body/Rule 39.1(iv). Nevertheless, a search has been executed for this claim. The search has been based on the alleged effects of the compound/composition.

**Box I.2**

Present claims 1-2 relate to an extremely large number of possible compounds. In fact, the claim contains so many variables that a lack of clarity and conciseness within the meaning of Article 6 PCT arises to such an extent as to render a meaningful search of the whole scope of the claims impossible.

Consequently, the search has been carried out for those parts of the application which appear to be clear and concise, namely mainly the compounds claimed in claim 10.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

25/02/01

International application No.

PCT/SE 00/02192

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP 0251536 A1	07/01/88	AU 7465487 A		07/01/88
		DK 319387 A		25/12/87
		FI 872774 A		25/12/87
		GB 8615416 D		00/00/00
		IL 82965 D		00/00/00
		JP 63005082 A		11/01/88
		NO 872625 A		28/12/87
		NZ 220770 A		26/02/90
		PT 85153 A,B		01/07/87
		ZA 8704446 A		27/04/88
		GB 8615417 D		00/00/00
		GB 8615418 D		00/00/00
		GB 8615419 D		00/00/00
		GB 8702683 D		00/00/00
		GB 8702685 D		00/00/00
		GB 8702686 D		00/00/00
<hr/>				
EP 0204215 B1	10/12/86	AU 5768886 A		27/11/86
		JP 7103110 B		08/11/95
		JP 61293975 A		24/12/86
		US 5869513 A		09/02/99
		ZA 8603859 A		29/07/87
<hr/>				
US 5576341 A	19/11/96	DE 69404200 D,T		08/01/98
		EP 0621035 A,B		26/10/94
		ES 2104223 T		01/10/97
		JP 6298611 A		25/10/94
		JP 8099808 A		16/04/96
<hr/>				